THE TECH ENGINEERING NEWS

MAY 1946
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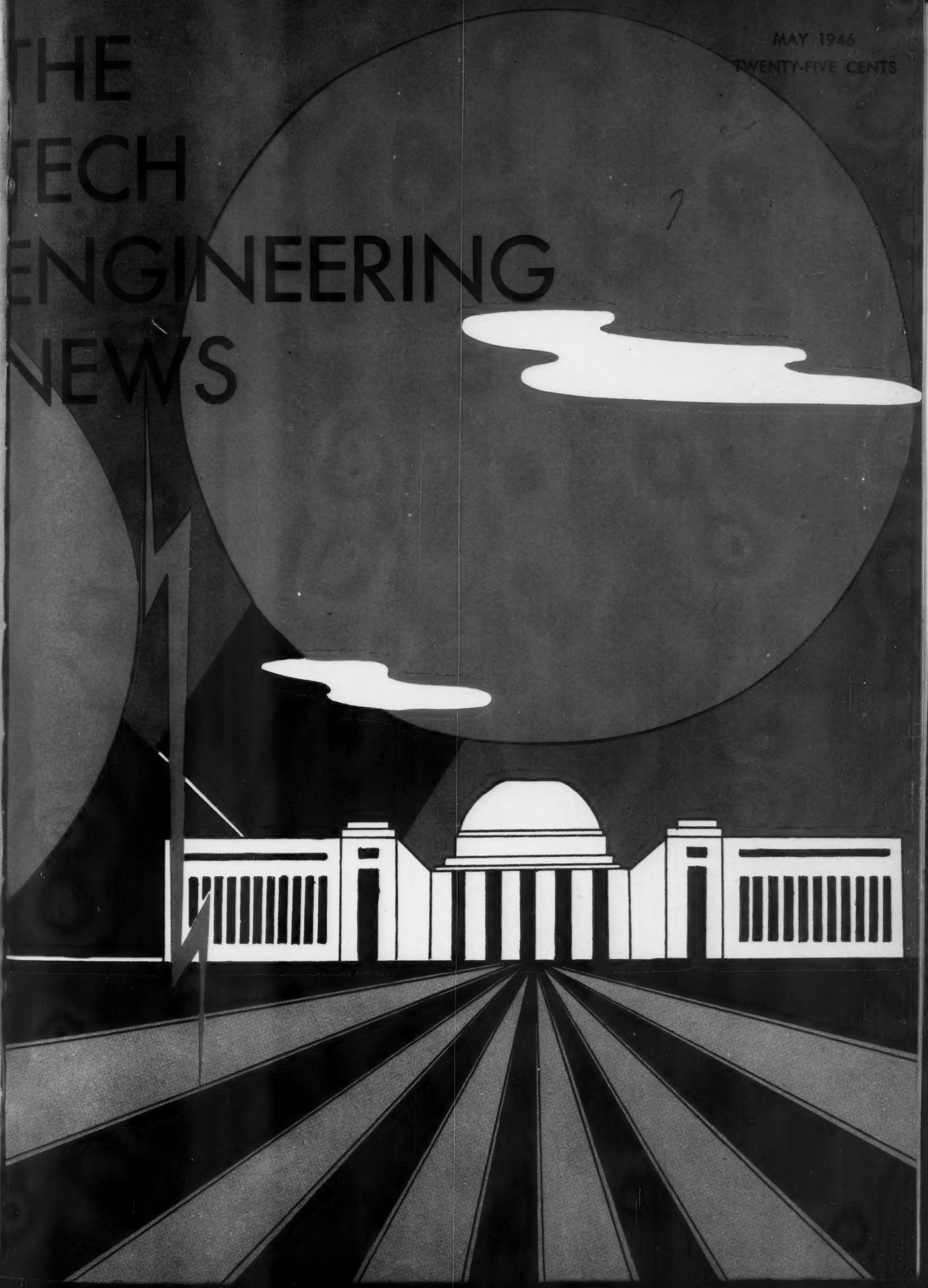
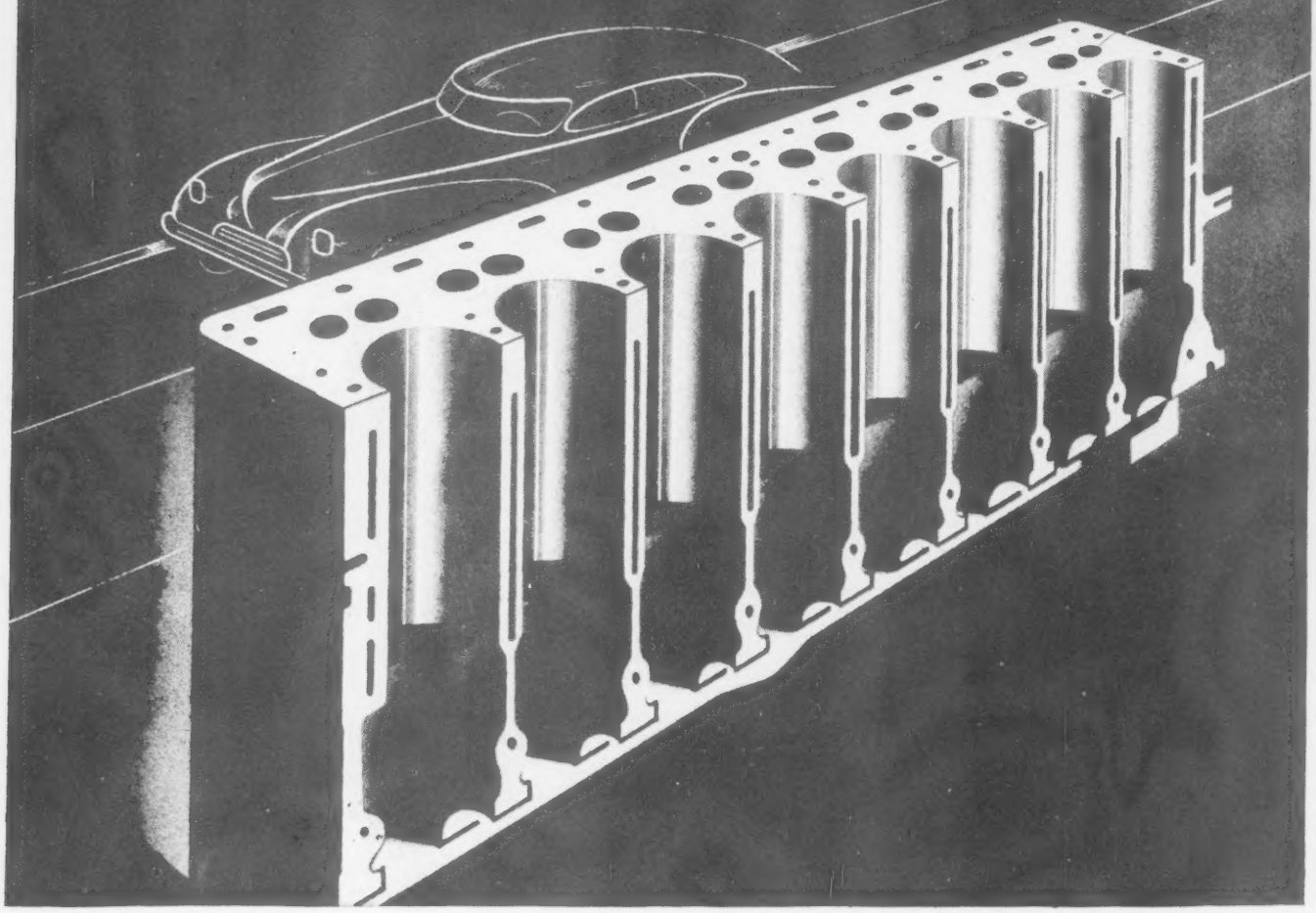


Molybdenum in cast iron promotes uniform hardness in varying sections.



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CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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MOLY

THE FLAME THAT CUTS *through Sea and Steel*

Men-of-war that "died" at Pearl Harbor lived again to fight at Omaha beach and Leyte. No small measure of credit for their resurrection belongs to the modern techniques of underwater cutting with the oxy-hydrogen flame and underwater welding with the electric arc. These methods are serving the nation's needs in wartime, and are also opening the way to new peacetime accomplishments in submarine salvage and construction.

Air Reduction has played a leading part in designing and manufacturing equipment for underwater cutting, as part of its program of progress which has given the world many new developments in welding, cutting and other related methods for modern metal-working.

AIRCO **AIR REDUCTION**
60 East 42nd Street, New York 17, N. Y.

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AIR REDUCTION SALES COMPANY
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WHEN THE LOOM CAME OUT OF THE KITCHEN

Weaving, as a household industry, was brought to an end in 1814 when Francis Cabot Lowell designed the first American power loom at Waltham, Massachusetts. With his brother-in-law and a friend, Lowell opened a mill where, for the first time in history, all the processes for converting cotton fiber into cloth were performed within the walls of one building by power . . . and the mill is still in operation.

Modern looms — as well as spinning frames, and other textile machinery — are, of course, equipped with anti-friction bearings. Many of these are made by SKF. For SKF originated the self-aligning ball bearing, widely used in the textile industry, and has pioneered many developments in this important industrial field during the last 30 years.

Since SKF makes so many types of ball and roller bearings, an SKF engineer can give you expert help in selecting

THE RIGHT BEARING FOR THE RIGHT PLACE

SKF INDUSTRIES, INC., PHILA., PA.

Linde SYNTHETIC SAPPHIRE

has proved its Worth

In Such Uses As . . .

BEARINGS which ensure accuracy of precision instruments.

THREAD GUIDES which resist the abrasive action of synthetic and natural fibers.

PRECISION GAGES which maintain dimensional fidelity and outwear steel gages over 100 times.

OIL BURNER NOZZLES which retain constant orifice size and resist the deposition of carbon on their highly polished surfaces.

BURNISHING WHEELS which produce high polish on non-ferrous metals.

PHONOGRAPH NEEDLES which reproduce faithfully over long periods of time without dulling their fine highly polished points.

WIRE GUIDE DIES which maintain size and shape of opening against constant friction.

GAGE POINTS which remain smooth and dirt-free for accurate gagings.

LINDE Synthetic Sapphire Has These Features . . .

1. Hardness = 9 Mohs' scale
2. Tensile strength = 65,000 psi
3. Resistance to commercial chemicals
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5. Melting point = 2,030 deg. C.
6. Thermal conductivity = 0.007 deg. C/cm²/cm
7. Can be bonded to metals
8. Economical flame-fabrication in rod form

Choose From These Two Forms

The word "Linde" is a trade-mark of The Linde Air Products Company

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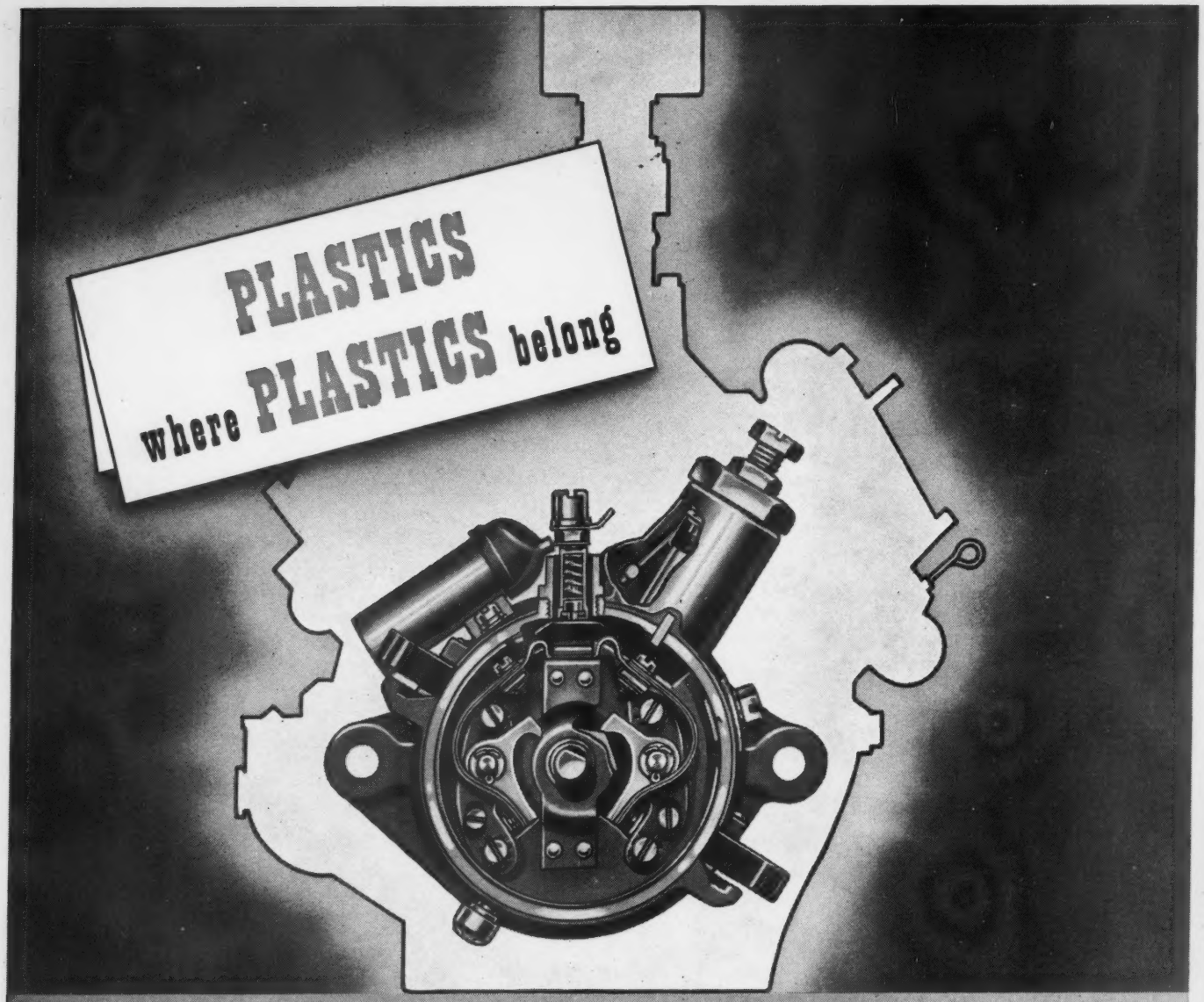

Using High Impact Fatigue Strength, Wear Resistance

THE BREAKER ARM is an important small part in any automotive ignition system. Synthane for this application is a good example of using plastics where plastics belong.

Synthane qualifies here because of its high resistance to impact fatigue, excellent wearing qualities, and insulating characteristics.

For these reasons, or possibly others, Synthane may be just what is needed in any product in which you may have a future interest. It's easy to find out, better to find out before you design.

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SYNTHANE

SYNTHANE TECHNICAL PLASTICS · DESIGN · MATERIALS · FABRICATION

Professional Activities Around Tech . . .

A. S. C. E.

A. S. C. E., dormant for many months, is being sparked to life. Its president, Robert Cuccioli, is now spearheading the drive for one hundred per cent membership in the Civil Engineering Department. At a meeting on Thursday, April 4, Dr. J. B. Wilbur, head of the Civil Engineering Department, explained fully the functions of the student chapter and brought out clearly the advantages which accrue to the individual as a result of membership in the American Society of Civil Engineers.

At the following meeting on April 24, Prof. C. B. Breed, a consulting engineer in Boston and former head of the Technology Civil Engineering Department, discussed the "Future for Civil Engineers" and prophesied bright prospects for many years. The abundance of construction and the shortage of trained civil engineers will continue for at least five and perhaps ten years.

An inspection trip, a motion picture, and a speaker are scheduled for the remaining programs this term.

The faculty advisor for the student organization is Prof. C. H. Norris.

A. S. M. E.

At the first A. S. M. E. meeting of this term on March 5, Dr. J. C. Hunsaker spoke to the A. S. M. E. members on "Your Future in Mechanical Engineering." Dr. Hunsaker outlined the history of mechanical engineering with regard to its development from a crude branch of science to its now specialized field of engineering application. He also stressed the importance of professional recognition of professional affiliation. Dr. W. M. Murray, A. S. M. E. faculty advisor, also spoke at this meeting on "A. S. M. E. Membership." Dr. Murray outlined the benefits received by being a member of the A. S. M. E.

At the second meeting of the A. S. M. E. some two weeks later, Prof. C. R. Soderberg spoke on "Gas Turbines." The history of the development of the gas turbine was outlined by Professor Soderberg, who brought the gas turbine up to date by describing its present-day mode of operation and application. Several slides describing the modern gas turbine under operating conditions were shown.

At the last meeting of the A. S. M. E. the Glen L. Martin Company's sound film "PBM-3 Wing Destruction Test" was shown. The film described the ultimate wing strength test made by the Glen L. Martin Company on the Navy's patrol bomber, *The Mariner*. The entire M. E. faculty was invited to this meeting.

On Saturday, May 4, the A. S. M. E. sent down a delegation to the Rhode Island State College at Kingston, R. I., for the New England Regional A. S. M. E. Conference. Tech competed for awards at this regional meeting. Prof. Harry Majors, Jr. accompanied the group, pinch-hitting for Professor Murray.

The A. S. M. E. Certificate of Award will be presented at the end of this term to the student most deserving of it, in recognition of his outstanding effort and accomplishment during this past year. An A. S. M. E. Jamboree is planned for the next meeting, but the date has not yet been set.

I. Ae. S.

The Institute of Aeronautical Sciences is very much alive and kicking here at Tech. The M. I. T. Student Branch boasts a membership list including nearly every Course XVI student.

Activities got off to an early start with the election of Melvin Zisfein as chairman, Howard Swemer as vice-chairman, John Norton as secretary-treasurer, and Ralph Krenkel as program chairman. A plant trip was made two weeks later, on March 15. Twenty-five members made a tour of the Chance-Vought and Sikorsky Aircraft plants in Bridgeport, Conn. Here they saw the famed Navy *Corsair* fighter and the R-5 helicopter on the production lines. A promised helicopter ride was cancelled because of bad weather.

The I. Ae. S. also sponsored an exhibition of American production-line pictures in Building 33. Many of these pictures depicted scenes similar to those seen by the select group on the tour.

On May 6 a meeting was held and a film, "The Development of the Helicopter," narrated by Igor Sikorsky, was shown. Future plans include a lecture by Professor Von Mises of Harvard and the launching of a new membership drive.

S. A. E.

The Society of Automotive Engineers has been quite active this term under its officers: Chairman M. R. Burman, Vice-Chairman J. R. High, and Secretary-Treasurer T. Zsembik.

On April 10, Professor Fales, Research Associate of the Mechanical Engineering Department and S. A. E.'s faculty advisor, addressed the members on European automobiles. He spoke of the different conditions existing in America and Europe and mentioned how they affected the designs produced in those places. In Europe fuel is very expensive and hard to get. The mass of the people are poor and cannot afford to buy an expensive car, nor can they buy them often. In America fuel is relatively cheap, and the large used car field has made buying a new car often profitable. Therefore in America cars are governed by the factors of style and saleability while new engineering design features are at a minimum.

The backbone of the automotive industry in Europe is the small car (like the Austin) which has about forty horsepower. (Europe has a tax on horsepower.) The sports car is also a favorite in Europe and is built for high speeds and fast maneuvers. Cars like the Rolls Royce are made to order and are very rare. Because engineers are in charge of industry rather than sales or business men, many new engineering advances have come from Europe — such as four-wheel brakes, independent wheel suspension, Diesel engines, balloon tires, and fluid drive.

On April 24 a movie, "Tornado in a Box," made by Allis-Chalmers, was shown in connection with a talk by Prof. E. S. Taylor on superchargers.

On May 7 a joint meeting with the New England

section of S. A. E. is to be held in Pritchet Hall. E. K. Blosse, supervisor of diesels on the Boston & Maine Railroad, spoke on "Railroading with Diesels." John A. C. Warner, the secretary-manager of the National S. A. E., also gave a short talk.

A plant trip tc General Electric's Jet Propulsion Division in Lynn, Mass., as well as a plant trip to the Mathewson Machine Tool Works, is being planned for some time in May. Also a movie and a talk by Prof. C. F. Taylor on the new Pratt & Whitney "Major" engine — 3000 horse power — is being arranged.

A. I. E. E.

The first A. I. E. E. lecture of the term was given by Prof. H. S. Caldwell, who spoke on the differential analyzer, which he helped to develop. With the aid of slides, Professor Caldwell "broke down" the analyzer into its three main components: the integrator, the multiplier, and the adder. The audience was first shown how each of these devices performs its specific job, and then how they are all combined to solve the multitude of problems that the analyzer is capable of working.

The following week, three small groups were taken through the rooms which house the M. I. T. differential analyzer, and were given a first-hand opportunity to watch the intricate mechanisms in operation. The problems are placed in the machines by means of three punched tapes upon which the initial conditions, required solutions, and equations are punched according to a specific code. Electrical contacts are made through the holes, the necessary components are combined, and the machine set in motion. Then, after a relatively short space of time, ranging from just a few minutes to several hours, depending on the complexity of the problem, the solutions are recorded by electric typewriters in the form of columns of numbers on a sheet of paper. In addition to this, it is possible to have the machine trace a graph of the problem's variables on a special revolving drum.

On April 1, a group of twenty-five members was taken through the General Radio Company's plant on Massachusetts Avenue in Cambridge. Students were guided by M. I. T. graduates of Course VI-A.

General Radio produces primarily high quality measuring equipment and frequency standards for use by commercial radio stations and other manufacturers. The group was shown through the shops where the aluminum chassis are stamped, drilled, and finished; through the coil winding rooms, the testing labs, and the workrooms where the sub-assemblies are put together. They were shown the company's "prize" product, a large frequency standard.

On April 10, the second lecture in the series, on "High Speed Photography," was given by Prof. H. E. Edgerton, who developed the stroboscopic technique for high speed photography. At the outset, Professor Edgerton defined the term "high speed photography" as photography at speeds above those at which mechanical photography breaks down, i.e., roughly between 1/2000 second and 1/1,000,000 second. After explaining the basic principles behind the stroboscopic technique, Professor Edgerton demonstrated the equipment used. By flashing one of the stroboscopic lamps at a rapidly whirling fan blade, for example, the blade was made to appear motionless. Some slides and motion pictures were shown giving further examples of "stopping" all types of action. The audience saw pictures of pigeons and hummingbirds in flight; eggs being dropped onto whirling fan blades; guns being fired and the bullets emerging in a cloud of vapor; the stress in a sheet of glass as it is broken by a hammer; and many other equally fascinating things.

On April 17 and again on April 24, a group of ten members were allowed by the Navy to tour the factories of the National Company, manufacturers of high quality receiving equipment. During the war, and even now, the National Company has made receivers for a multitude of Navy uses, and the A. I. E. E. was very fortunate in being allowed to tour the plant.

The National Company makes most of the major components which go into its sets, with the exception of tubes, meters, and speakers. The chassis are stamped, welded, and drilled on the first floor of the factory. On this floor, too, the tube sockets are riveted into place. The chassis are then sent to the upper floors where girls and women solder the components into place. Each woman is trained to insert just one piece, and this, coupled with color codes used in identifying wires and terminals, and wiring diagrams, makes for very little error. Also on the upper floors are the coil winding rooms where special winding machines make the large variety of coils needed. When the sub-assemblies are finished, they are inspected and tested in a quality control laboratory by both the Company's and the Navy's inspectors. All those which pass inspection are then sent to the other factory to be incorporated into the completed sets. Receivers that are accepted are given a tropicalizing treatment to prevent fungus growth in the wiring should the equipment be used in the jungles. This tropicalizing treatment was developed by the Navy after it was found that a set could not be operated for more than forty-eight hours in the tropics before the fungus growth became so thick that the set was short-circuited.

On May 1, Prof. John G. Trump lectured to a group of eighty persons on the subject of "High Voltage X-Rays and Cathode Rays." Professor Trump discussed the use of high-voltage X-rays in the medical field. Confining his lecture to generation of high voltages by electrostatic fields, he demonstrated his point by generating a high voltage with a machine working on the principle of the Van De Graff generator. Professor Trump stated that methods similar to the ones he used have been used to produce the highest voltage X-rays known to date, but that the method is not widely used because of its great expense and safety hazard. X-rays which are used medicinally, he said, are still being generated in a manner similar to that used by Roentgen, who first generated X-rays, the only changes being that the voltage of the system has been raised to 300 volts from the original 260 volts. Professor Trump expressed hope that the future would bring much greater development and research in the X-ray field.

Turning to the use of X-rays in the medicinal field, Professor Trump showed slides of the effects of X-rays on superficial and deep-rooted malignancies, and he explained how various potentials produce different effects on the diseased tissues. He also explained some of the techniques used by medical men in the treatment of cancer in various parts of the body, with both X-rays and with cathode rays. Professor Trump stated that the cathode rays were more beneficial because they deteriorate more rapidly, and therefore cause less damage to the healthy tissue.

Still in the future for A. I. E. E. members this term is a plant trip to the Westinghouse transmitter at Hull, Mass., on May 8, and a lecture by Prof. A. R. von Hippel, who will speak on "New Concepts in Electrical Engineering" on May 13. The term's activities will conclude with a dinner to be held, tentatively, on May 28.

Double Bedroom in new Budd sleeping car, showing the enclosed toilet room and shower, and the wardrobe next to it. A double-occupied bedroom is one of the most economical of all sleeping accommodations.

NEW BUDD-DESIGNED DOUBLE BEDROOMS ACCENT *Privacy*

Every bed in Budd-designed sleeping rooms is pre-made, ready to be drawn into place for immediate use when you want it without regard to the porter's strenuous schedule.

In these double bedrooms, the toilet facilities are moved away from the window to the aisle side of the room *and are enclosed*. Yes, enclosed in a separate compartment with a door. This exclusive Budd Double Bedroom feature for the first time gives the unembarrassed privacy essential for two people. The arrangement also permits a wide, panorama window which double bedrooms have never had before, so that both passengers can enjoy the scenery . . . and unlimited legroom.

In the new post-war sleeping cars which Budd is building, double bedrooms are arranged in pairs. One has beds lengthwise of the car, the next one crosswise. Pleases everybody.

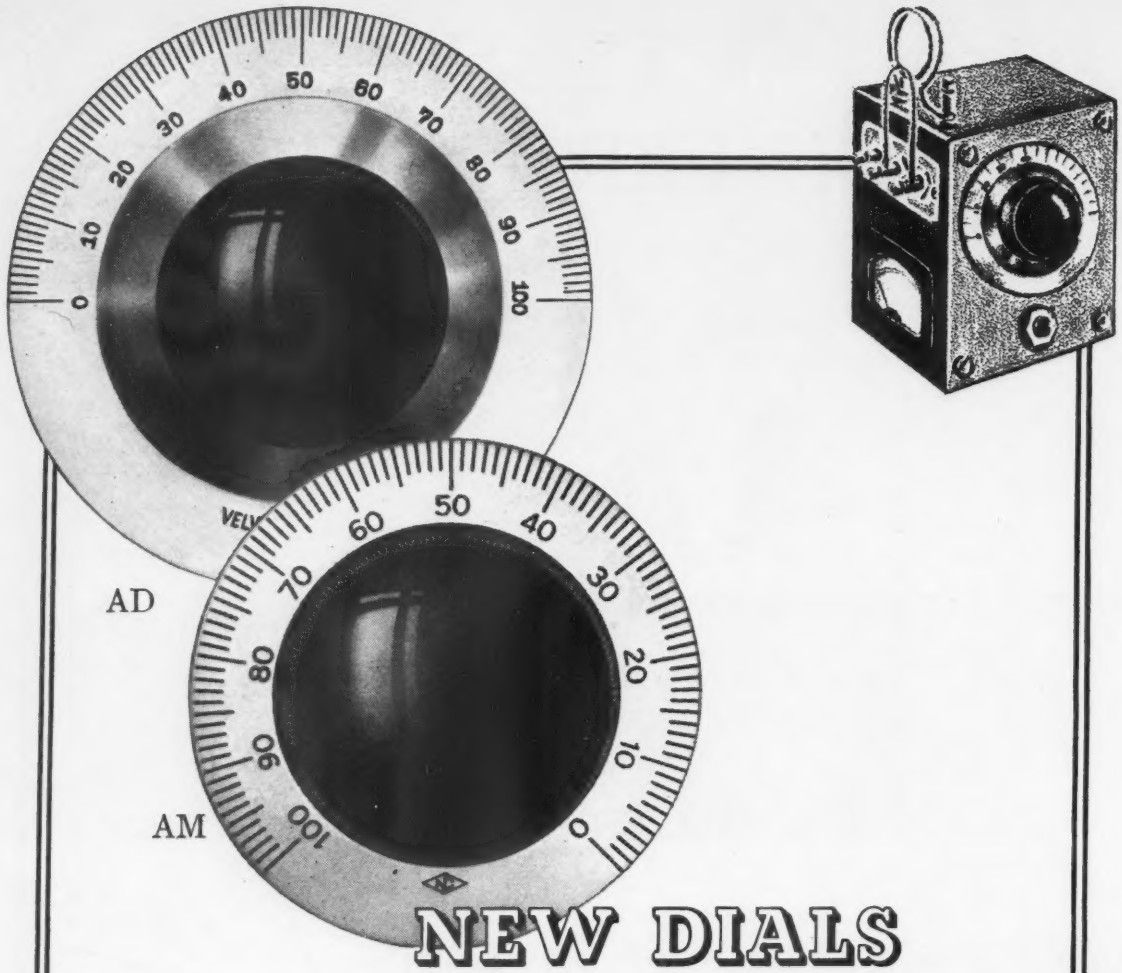
Two adjoining double bedrooms may be combined into a spacious apartment for family or group travel, simply by folding back the partition. There you have the supreme Master Room, originated by Budd to accommodate six by day, four by night.

New stainless steel sleeping cars of Budd design will soon be in service on America's foremost railroads from coast to coast. Budd-built trains are stainless steel—the strongest and safest material suitable for railway car structures.

EDWARD G. BUDD MANUFACTURING COMPANY • PHILADELPHIA • DETROIT Budd

Originators of stainless steel lightweight trains, ALLSTEEL* *auto bodies, stainless steel highway truck trailers and marine structures. Inventors of the* SHOTWELD* *system of fabricating hi-tensile steel.*

*REG. U. S. PAT. OFF.



NEW DIALS

Wartime requirements for accurate smooth-working dials resulted in the design of these two new models. Both make use of the time-tested "Velvet Vernier" drive unit which for more than twenty years has been a favorite because of its incomparably smooth action and sensitive control. The Type AM Dial is three inches in diameter and is available with 2, 3, 4, 5 or 6 scale. The four-inch Type AD Dial is made with 2, 3, 4 or 5 scale. Both are handsome in appearance and moderate in cost.

DIAL SCALES

Scale	Divisions	Rotation	Direction of Condenser Rotation for increase of dial reading
2	0-100	180°	Counter Clockwise
3	100-0	180°	Clockwise
4	150-0	270°	Clockwise
5	200-0	360°	Clockwise
6	0-150	270°	Counter Clockwise

ARMY E NAVY

ARMY E NAVY

NATIONAL COMPANY, INC., MALDEN, MASS. U.S.A.

The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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TECHNOLOGY TODAY, SHOWING THE WESTGATE HOUSING PROJECT AND SOME OF THE RADIATION LABS

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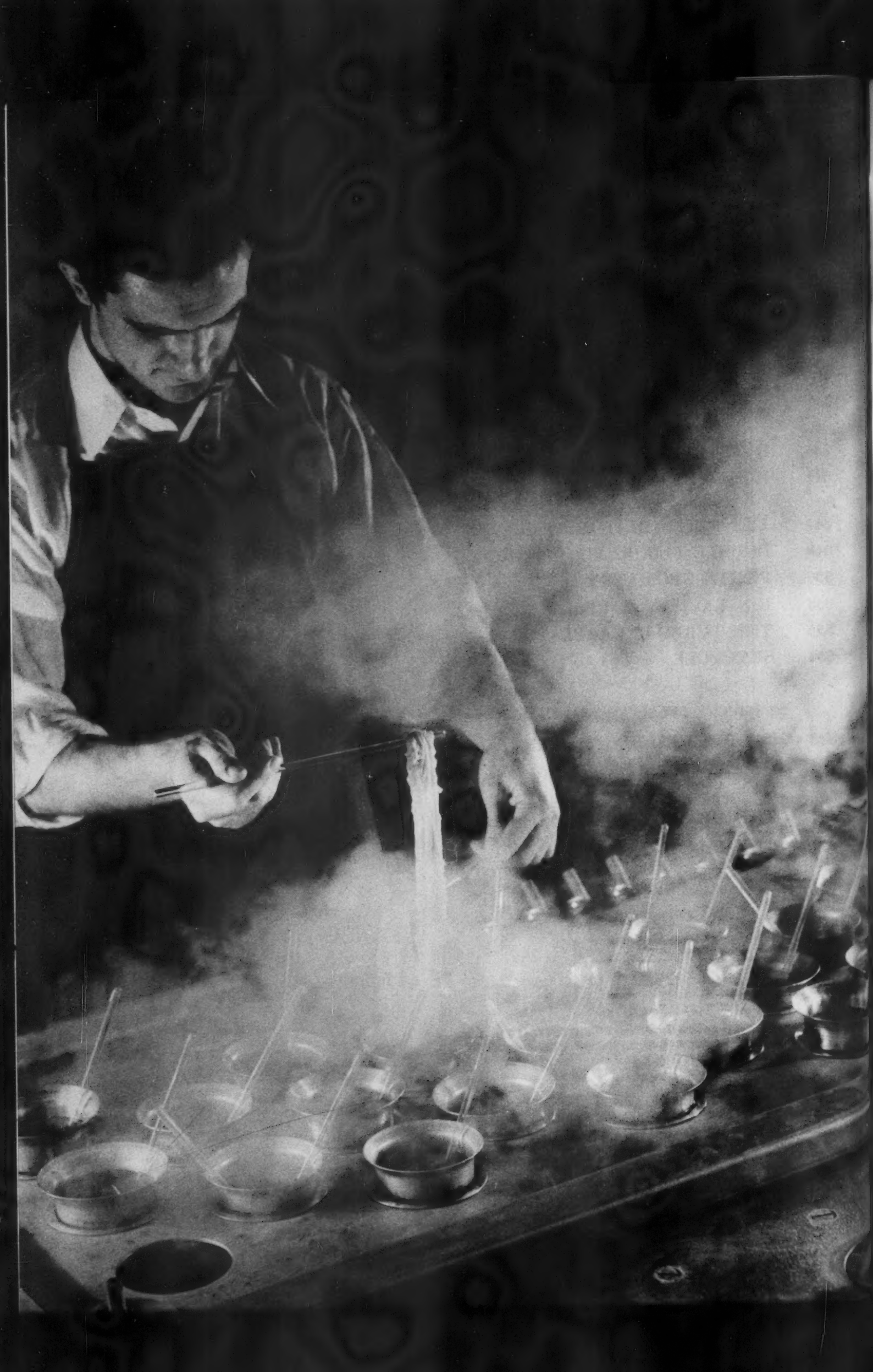
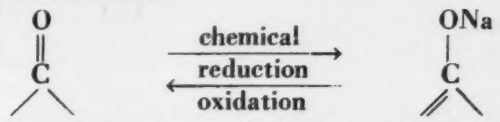


Dyestuffs in Action!

By EDWARD M. KOSOWER, 2–48

MOST people take their surroundings for granted; the housewife spreading rich, yellow butter on bread could never dream that it was chemical know-how which colored the rare dish; the husband whose air raid warden's job leads him to familiarity with blackout paint would never think of the experimentation and work necessary to produce this practical marvel. And so it goes in every application of science.

According to the Department of Commerce, one of the notable developments in the dye industry during the war was the manufacture and extensive use of anthraquinone vat dyes superior to most of the previously available compounds. For the fastest dyeing of cotton fabrics used in uniforms, tentage, etc., the anthraquinone vat dyestuffs are second to none. Vat dyestuffs are sold in an insoluble colored form as powder or paste and are used by converting them to the less-colored or colorless, soluble leuco-compounds. The latter are soluble in alkaline solution only, but since this is the condition of the solution used in dyeing, this property does not matter.



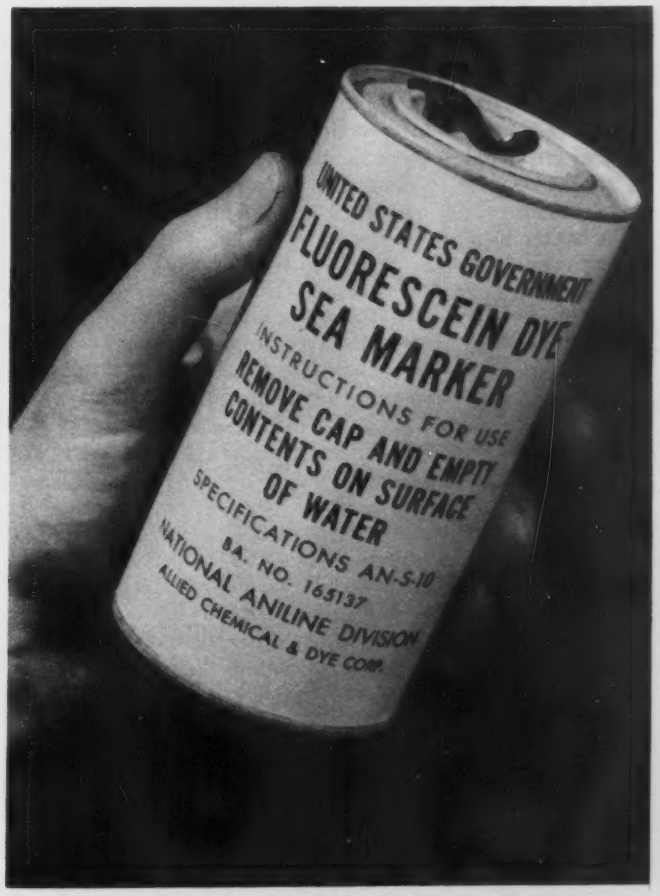
The leuco-compounds are formed by reducing the anthraquinone dyes with sodium hydrosulfite and caustic soda. The solution penetrates the cotton fabric placed within it and is held by the cotton fabric until oxidation changes the leuco-compound to the original dye. Because the dye is within the fabric, it is so firmly held as to be but little affected by washing, bleaching, exposure to light and other dye-attacking agents. Vat dyes are among the world's most ancient textile colors. Those produced synthetically in today's factories far surpass in all respects the classical standbys, indigo and Tyrian purple, and, of course, are much cheaper. Woolens dyed with Tyrian purple, obtained from a Mediterranean shellfish, are said to have brought the equivalent of $350 a pound, many centuries ago. None but the nobility could afford such luxuries. Hence the expression, "born to the purple." Tyrian purple can be made synthetically in the laboratory; it is 6,6′-dibromo indigo. The ancients reduced the dye to the leuco form in fermentation vats, using grape juice or other sugary liquids to promote fermentation. It was these vats which gave this family of dyestuffs its name.

The most recent and efficient method of using these dyestuffs is called the pad-steam method developed by research scientists in DuPont's Technical laboratory. The usual hydrosulfite reduction is a highly alkaline process, but the new practice minimizes this objection to the method by substituting a few seconds of steam for fifteen to sixty minutes of treatment in a bath of a somewhat lower temperature. Thus fine fabrics other than cheap cotton goods can be dyed with the excellent anthraquinone and indanthrene vat dyes. The new process also avoids much of the stretching and distortion suffered by fine fabrics if run through the long series of rollers encountered in the standard, continuous dyeing procedures.

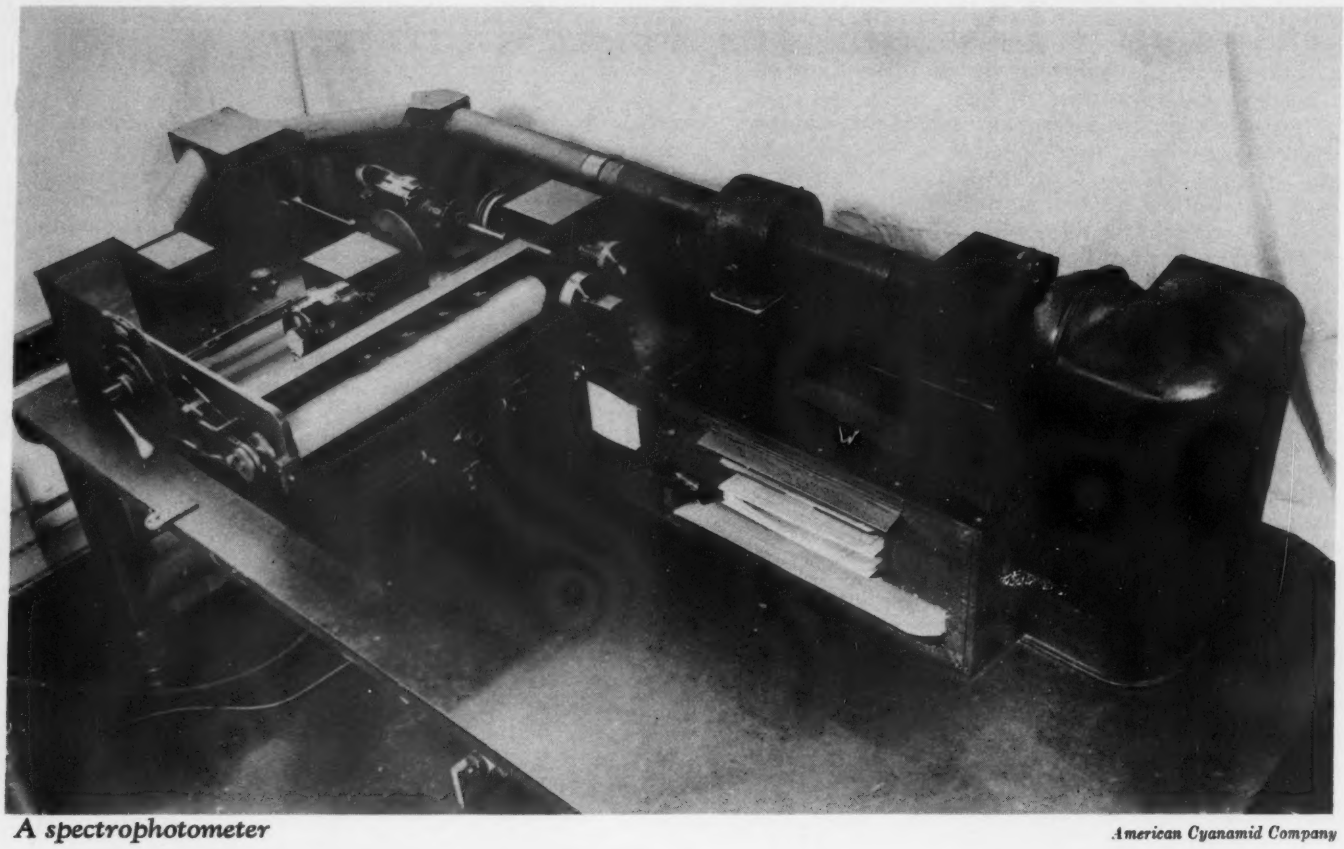
About fifteen years ago, the first practical process for the thiocyanogenation of amines was developed. As a result, it became possible to prepare dyes containing the thiocyano group, —SCN, which have been shown to have certain properties superior to the corresponding dyes containing chloro, Cl—, or cyano, CN—. Recently, much research has been done on this class of dyes and the Koppers Company through its Tar and Chemical Division is selling commercially the primary raw material, ammonium thiocyanate. The process is essentially: A soluble thiocyanate is added to a mixture of aniline and dilute hydrochloric acid. A solution of copper sulfate is then added with stirring. From the mixture, a very good yield of para-thiocyanoaniline: can be isolated. The process, with some modification, is applicable to most amines and most phenols. The German chemical and manufacturing syndicate, I. G. Farbenindustrie, prepared excellent wool dyes by coupling a series of thiocyanamines with pyrazolones, amino quinolines, and amido naphtholsulfonic acids, and these have (supposedly, at the Reich's word = "währheit.") improved

One of the cans of dye used during the war to locate airmen downed at sea

Allied Chemical and Dye Corp.



fastness to washing and milling, good levelling (evenness of color in dyed material) and light fastness properties. Other experiments in England, at the laboratory of Manchester Oxide Co., Ltd., have defined further the various properties of the thiocyano group in dyestuffs. The group has a marked deepening effect on the color of the dyestuff and, in this respect, is stronger



A spectrophotometer — *American Cyanamid Company*

than the chloro group but weaker than the nitro group. For instance, by replacing the free para-hydrogen in Oil Yellow D with a thiocyano group, a pure yellow is converted to a golden yellow; by substituting a thiocyano group for a hydrogen in Amidonaphthol Red G, a yellowish-red is changed to a magenta. In many cases, the presence of a thiocyano group in a dye resulted in a better degree of exhausting in the dye bath used to apply the dyestuff. In commercial application, this would mean greater savings to the dyer, since less dyestuff would be used for every unit weight of yarn used. Unfortunately, there still remains to be found stabilizing agents for these dyestuffs, and a cheaper method of manufacture is still in the offing.

A new science (or pseudo-science) sprang like Minerva from the realization that visual shelter was an extremely valuable weapon of offense and defense. This was camouflage, and, to be sure, we were merely copying the old lessons of instinctive concealment. The difference was that we used manufactured and standardized coloring materials in planned patterns of confusion — sometimes even more effective than the best that Mother Nature could display in her domain. In the laboratory, the bases for camouflage were worked out using various dyes and textiles and sampling their effect on infra-red film. Poor camouflage may have properties of invisibility when examined under normal light but if it shows up upon spectrophotometric examination to be what it is, the so-called camouflage is worthless from a military standpoint. The enemy, by simple infra-red photography, can pierce the secrets of camouflage unless it is designed with this contingency in mind. Determination of the infra-red and normal-light values of camouflage can be made with a spectrophotometer. In actual construction, color is admittedly of less importance than shadows, tracks, and trails but it would certainly be unfortunate if an otherwise perfect camouflage job failed because the job had bad infra-red properties for the enemy to take note of and decipher. Many new dyes were made to order for the special requirements of the camoufleur during the war.

Complete darkness reigned in the silent city — only at street corners were there small spots of light and even these were carefully shielded against possible detection from above. These small spots of light were orange and consisted of circular dabs of Rhodamine B illuminated by ultra-violet light. Enemy bombers passed noisily over the city searching, searching. . . . But the problem of blackout had been solved by the engineers and chemists of the government — the city was safe from external detection. — *From "Blackout," a novel by B. A. Beaver, 1945.*

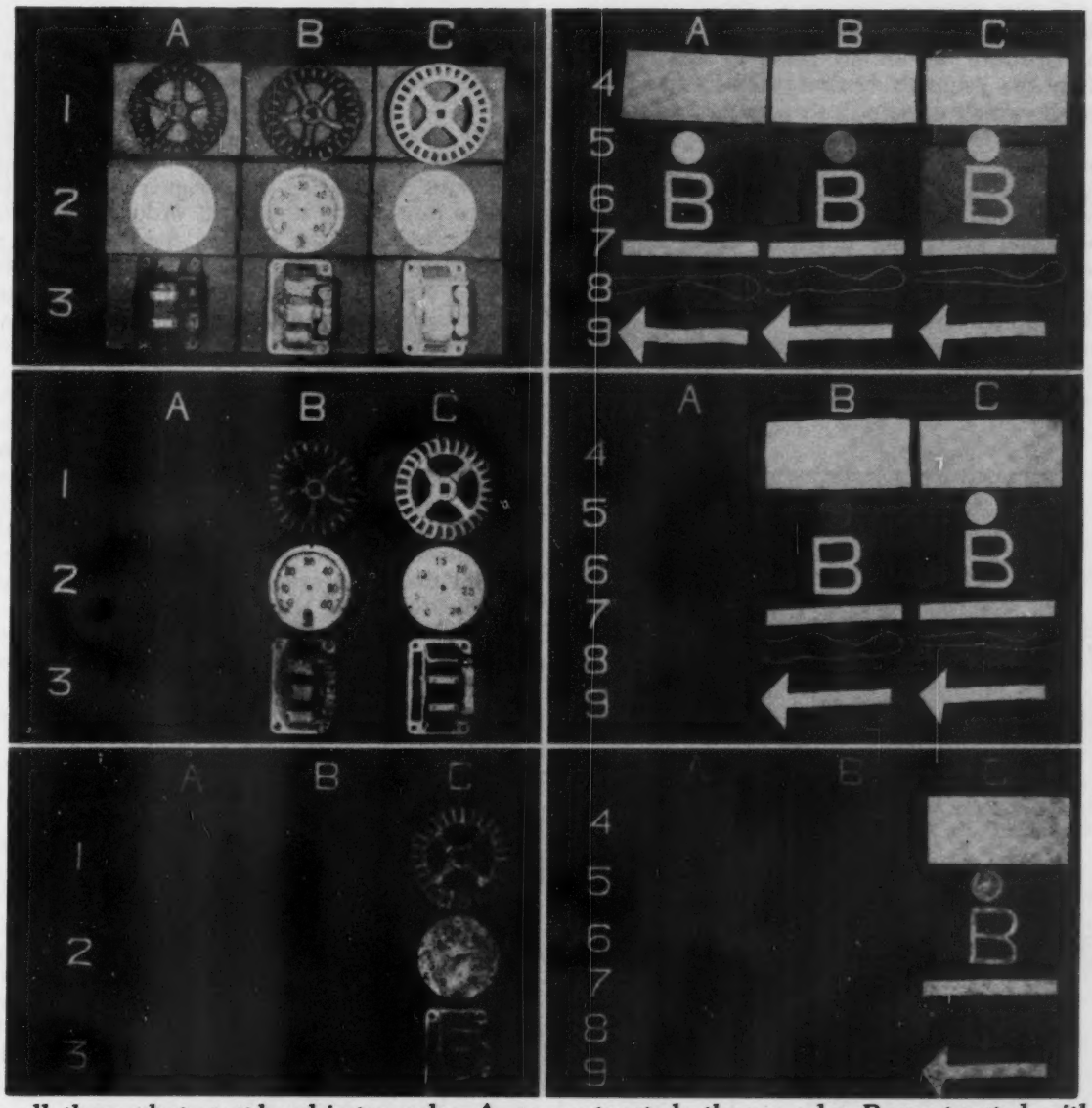
These small spots can mean the safety of a city, a city that cannot stop its industry under the threat of bombing. The most important organic compounds that fluoresce are the dyestuffs. Many dyes give a brilliance under ultra-violet radiation unequaled by any known mineral specimens and by very few, if any, luminous pigments. Wide ranges of color can be obtained in dyes after they have been applied to textiles, ranging from violet through greenish and reddish blues, many variations of green, yellows from the extremely green shades to the very reddish tones, oranges, light and medium browns, scarlets, crimsons, and cardinals to dark, rich shades of red. Compositions can be prepared from these dyes, i.e., dyed yarn, mixed lacquers, resins, paints, varnish, colored and fluorescent papers, cellophanes, rayons which will exhibit these colors under "invisible light" can be prepared. The possibilities are tremendous, especially in the luxury clothing field. Various dyes respond selectively to different wavelengths of ultra-violet light and by making a piece of material from a combination of dyes in patterns, it can be made to change color and pattern under the illumination of different ultra-violet rays placed in a room. This proposition should prove attractive to America's fashion-conscious females. (Of course, the physical effects of purified ultra-violet light still must

be investigated.) Imagine a woman depicting a whole story on her dress as she danced around a room. More practically, the greatest use of these dyestuffs is in industry for protection and use during blackouts — factories can continue running with the machinery outlined by luminous light invisible to the searching aircraft; the peacetime use in theaters and other darkened places is obvious. In case it *is* necessary to use normal illumination during a blackout, light shielding is required. This can be accomplished with heavy cotton drapes dyed with one of a number of formulas among which the best were Aniline Black, Black JD, Sulfur Black 5GCF, Fast Rubine CA+Brown M, and Blue RW+Black R (Navy Blue). Although many parts of the United States were supplied with this type of material during the war, it was in England that these materials met the tests of actual combat and were proved. The combat cloth had the additional quality of transmitting no infra-red light as well as no visible light.

A practical psychologist once found that pink lemonade had more sales appeal to circus crowds than the uncolored ade. In a like manner, pharmacists and dietitians have found that colored materia medica and attractively colored foods are more readily accepted by the petulant or finicky sick. Psychiatrists administer a different colored sugar pill for each imagined ailment of the hypochondriacal patient. Again, the subtle application of a little color to their cheeks and lips have enabled women to "make friends and influence people" and even to change the course of world history. These few illustrations indicate the relative importance and value of coloring agents in food, drugs, and cosmetics.

The most important specification for food and drug

(*Continued on page 368*)



In all these photographs objects under A are untreated; those under B are treated with fluorescent chemicals; those under C, with compounds that are both phosphorescent and fluorescent. The two top pictures were taken in ordinary light. Ultraviolet light was used for the center photos. The bottom two were taken in a blackened room using no light whatsoever. Only the objects coated with phosphorescent chemicals could be seen in total darkness. By shining a weak ultraviolet light on fluorescent materials or by using phosphorescent chemicals, valves (1), dials (2), switches (3), paper sheets (4), plastic buttons (5), letters (6), cloth strips (7), thread (8), and arrows (9) — all these and many more can help keep an industrial plant operating in a black-out.

High Temperature Hot Water Heating

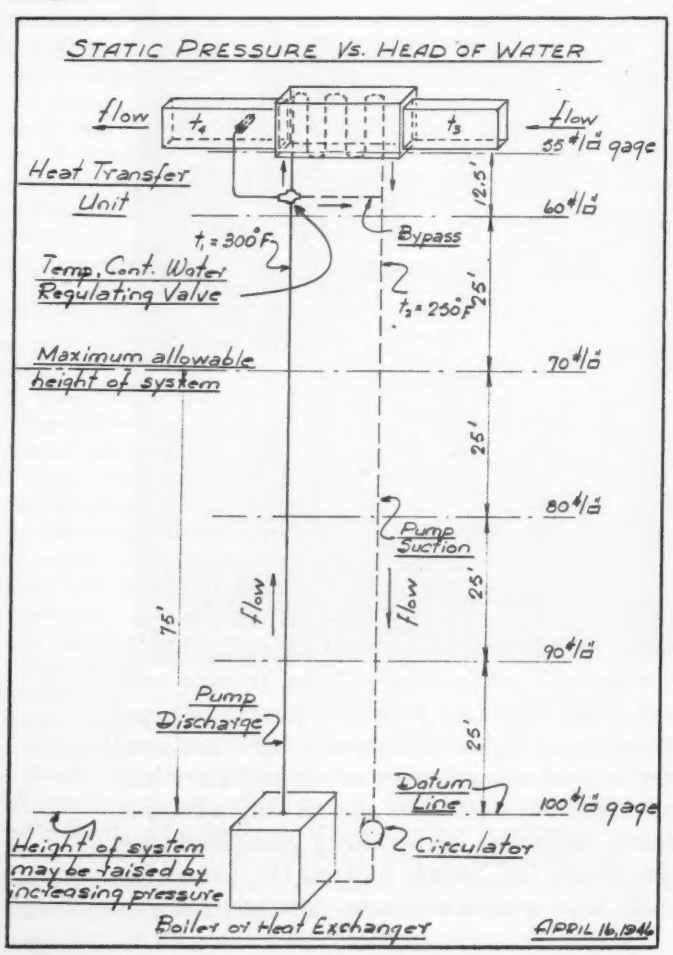
By ALBERT I. BRAYMAN, 10–47

MODERN engineering methods have made increasing use of higher operating temperatures in hot water heat transfer systems than has been customary in the past. Up to the present time in such systems water temperatures of approximately 200° F. have been predominantly used, but there has been a growing tendency to operate at temperatures above those corresponding to the normal atmospheric boiling point — 212°.

There are now some systems in existence operating at 250°. But because of the necessity of maintaining a continuous pressure within all parts of the system greater than the system's critical pressure (i.e., the pressure below which water will flash into steam), temperatures above 250° have not been used. Even at this temperature a pressure greater than 15 lbs./sq. in. gage would have to be maintained within the system to prevent the water from flashing into steam.

Although this writer does not wish to state that a system designed for a particular type of heat transfer should operate between definite restrictive limits of water temperatures and pressures, there are circumstances in these high temperature fluid flow problems in which it is advisable to do just that. Related to this choice of operating conditions are the cost of the system; the efficiency of the system; the value received for initial cost; the auxiliary equipment required for the operation of the system; and many other practical considerations.

Figure 1



Of primary consideration in any continuous temperature flow process is the ultimate objective of obtaining final process fluid conditions requisite for the particular installation. By way of explanation, it may be required in a certain chemical heat transfer process to obtain a final 250° temperature of the chemical while it is in a gaseous form. With such a problem the temperature of the heating medium must of necessity be well above 250° to obtain desired results. But just how high above this nominal temperature it is necessary to go and how to maintain these conditions constant are the problems confronting the designer of said system.

As previously stated, in order to maintain high temperatures of the heating medium, high pressures within the system must be used. (See Figure 3.) As can be seen from this graph, in order to maintain a water temperature of 250° within the system, a pressure above 15 lbs./sq. in. would also have to be maintained. Proceeding to the right on the temperature scale, at 300° the critical pressure is approximately 52 lbs./sq. in. Proceeding still further to the right, at 344° the critical pressure is approximately 110 lbs./sq. in. Thus it will be noted that the curve takes a sharp increase as we go further out on the temperature scale.

For many apparent reasons it is inadvisable to go beyond the 300° mark. And even at this temperature, within the entire system would have to be maintained a pressure greater than 52 lbs./sq. in.

In the present-day conventional hot water heating system operating under forced water circulation, water temperature differentials through the heat transfer equipment have not often exceeded 20°. This practice has necessitated the use of large volumes of water to obtain desired results. Not only have large volumes of water been used, but the equipment itself has had to be oversized. I use the word "oversized" not in the sense that some of the equipment is being wasted, but in the sense that the large bulk of the equipment would not be necessary if only the initial temperature of the heating medium could be raised, and perhaps a larger temperature differential obtained through the equipment. To reduce the volume of water used, the size of the piping, and other related equipment are the objectives of this proposed system. By operating at 300° rather than at 200° and by utilizing a 50° rather than a 20° differential through the equipment, a new phase of hot water heating comes into the picture.

It is proposed that this system will be operated at 300°; this temperature of the water maintained under a pressure of 100 lbs./sq. in. at the datum line of the system. (See Figure 1.) Such a system, since it can easily utilize a 50° temperature differential through the heating units, can operate on a smaller volume of water for a given heating load. That is, of course, should the final condition of fluid to be heated permit this differential. If not, the initial temperature of the heating medium (water) would have to be still further raised;

but as I have previously pointed out. pressure requirements increase sharply above 300°.

It may also be opportune to note at this point that with the "300° system" steam or vapor may be generated from an evaporator by the use of 300° submerged hot water coils. This makes the proposed system somewhat more universal in its application than otherwise would be thought of it. (See Figure 2.)

To begin with, it may be well to understand that a system such as that proposed would be entirely self-contained, constantly under pressure, water flow by forced circulation, and the medium to be heated in a liquid, gaseous or vapor state. The system would be operated under continuous or intermittent flow conditions, the water and other medium both entering and leaving the heat transfer units continuously or periodically. As can be seen, this proposed system has an unlimited field of application; it may be used for almost any application where an automatic temperature-controlled heat transfer process is required; however, for practical reasons, its use would be mainly for industrial purposes.

In any system of heat transfer, regardless of the nature of the heating or heated media, it is first necessary to calculate the heating requirement of each individual heating unit. In so doing the total heating load may be obtained by summing up the individual loads. However, no effort will be made to calculate the external heating requirements for any particular application, as that is beyond the scope of this paper. Each specific computation having variable requirements would be an engineering problem in itself.

After having computed the individual heating requirements of each heat transfer unit, the volume of water required to maintain the computed heat transfer may be determined from the general fundamental equation

$$H = M \times C \times dT \qquad (1)$$

where,

H = Btu/hr. heating load of heating unit.
M = Pounds of water/hr. flowing through the unit.
C = Specific heat of water (taken as 1.00).
dT = Water temperature differential.

This formula may now be put in the form

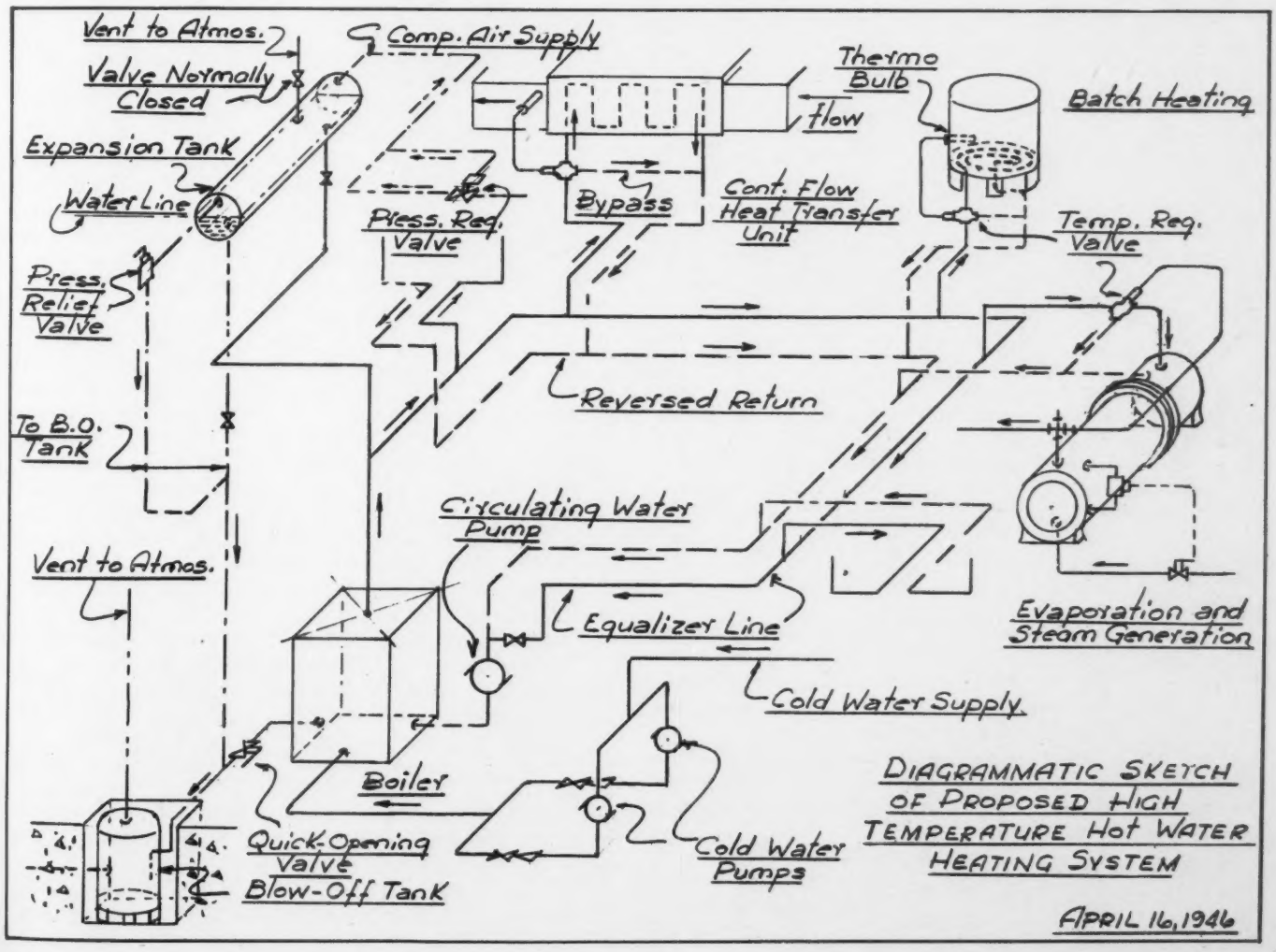
$$H = Gpm \times 60 \times 8.33 \times 1 \times S.G. \times dT \qquad (2)$$

where,

Gpm = Gallons of water/min.
8.33 = Weight of 1 gal. of water at maximum density.
$S.G.$ = Specific gravity of water. (See Figure 4.)

To compute the gallons of water required per minute at 300°, utilizing a 50° temperature differential, the

Figure 2



above formula may be put in the form

$$Gpm = \frac{H}{60\times 8.33\times 1\times 0.97\times 50^\circ} = \frac{H}{23000} \qquad (3)$$

Having arrived at this result, a comparative study may now be made with the conventional system operating at 200° and utilizing a 20° differential. Substituting these values in equation (2) we have,

$$Gpm = \frac{H}{60\times 8.33\times 1\times 0.97\times 20^\circ} = \frac{H}{9700}$$

From this it can be seen that for a given heating load only *42 per cent* of the water required in the conventional system will be required in the proposed system.

Again in making a comparative study of the possible heat emission from the heat transfer units where the two fluids (the heating and heated media) are in continuous flow, the rate of heat emission will be proportional to the temperature difference between the two

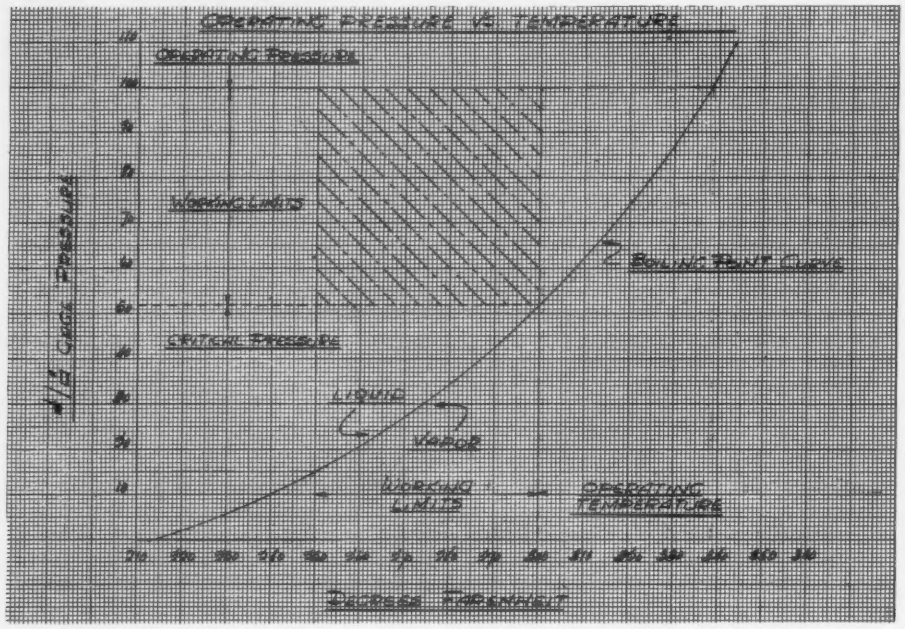


Figure 3

fluids. However, as both fluid temperatures are varying through the heat transfer units, a logarithmic mean temperature difference basis must be used in the calculations. This may be expressed in the form

$$LMTD = \frac{dT_1 - dT_2}{\text{Log}_e \frac{dT_1}{dT_2}} \qquad (4)$$

where,

$LMTD$ = Logarithmic mean temperature difference.
dT_1 = Greater temperature difference between the two fluids $(t_1 - t_3)$. (See Figure 1.)
dT_2 = Lesser temperature difference between the two fluids $(t_2 - t_4)$. (See Figure 1.)

Assuming arbitrary values of the heated medium t_3 and t_4 to be 60° and 120° respectively, and taking those of the water t_1 and t_2 at 300° and 250° respectively, we obtain

$$LMTD = \frac{(t_1 - t_3) - (t_2 - t_4)}{\text{Log}_e \frac{(t_1 - t_3)}{(t_2 - t_4)}}$$

$$= \frac{(300 - 60) - (250 - 120)}{\text{Log}_e \frac{(300 - 60)}{(250 - 120)}} = 180^\circ$$

In the conventional system with the 200° operating temperature and the 20° differential the above equation becomes

$$LMTD = \frac{(200 - 60) - (180 - 120)}{\text{Log}_e \frac{(200 - 60)}{(180 - 120)}} = 95^\circ$$

Substituting both of the above values of $LMTD$ for the given heating load H in the equation

$$H = A \times U \times LMTD \qquad (5)$$

where,

A = Sq. ft. of coil surface of heat transfer unit
U = Coefficient of heat transfer of coil surface expressed in Btu/hr./sq. ft. of coil surface/degree $LMTD$,

and assuming the value of U to be constant in both of the above cases, we find that about *50 per cent* of the coil surface is required when operating under the proposed conditions.

In summation, it can be seen that the proposed system is both more efficient in operation and less expensive to install than the conventional ones in present-day use. Some may question this last statement with regard to cost of installation, but in any event the cost of the proposed system will not exceed that of the conventional 200° system.

Since we have proven to our satisfaction that the 300° system has sufficient merit to warrant our designing one, the problem now presents itself of maintaining a 300° water temperature in a closed system. And if I may repeat myself again, this can be done only by maintaining a pressure within the entire system greater than that corresponding to the 300° boiling point temperature of the water. Looking again at Figure 3, a gage pressure greater than 52 lbs./sq. in. is required to prevent the water from flashing into steam. However, this minimum pressure requirement must be supplemented by a greater one to allow for flexibility of operation. Noting Figure 3, an arbitrary gage pressure of 100 lbs./sq. in. was selected to allow for this "play within the system." And not only for this last consideration, but to permit a 75-ft. head to be maintained. (A theoretical 115-ft. head of vertical height on the system is possible.) (See Figure 1.) The above reduction of system height takes into account friction of flow and any other factors that may present themselves once the system has been put into operation.

Referring to both Figures 4 and 5, one may notice that for every 2.5 ft. of system height 1 lb./sq. in. static pressure head is lost to the system, so at a height of 75 ft. above the datum line the system loses 30 lbs./sq. in., making its net effective pressure at that point 70 lbs./sq. in. This still allows a "play" within the system of 18 lbs./sq. in. obtained by subtracting the boiling point pressure of 52 lbs./sq. in. from the 70 lbs./sq. in. system pressure at the 75-ft. height.

It should be noted that for a given height above the datum line the pressure in both the supply and return lines is approximately equal. This applies to any height in the entire system and is one of the basic factors on the design of this system. The circulating pump operates merely against the friction of flow in

the piping and the equipment, neglecting system height.

The method of maintaining a pressure of 100 lbs./sq. in. within the system may be accomplished in either or both of two ways: (1) by boosting up the water main pressure by means of a cold water supply pump, and (2) by connecting an external compressed air supply line to the expansion tank at the highest point of the system. (See Figure 2.) The cold water supply pump may be operated and controlled by a pressure controller located at a convenient point in the system or at the datum line. The compressed air supply may be governed or regulated in a similar manner. One such arrangement is shown in Figure 2. It may be entirely possible to regulate the pressure of the water by a combination of the above methods; each serving as an insurance against the failure of the other, thus assuring the system of an external pressure supply at all times.

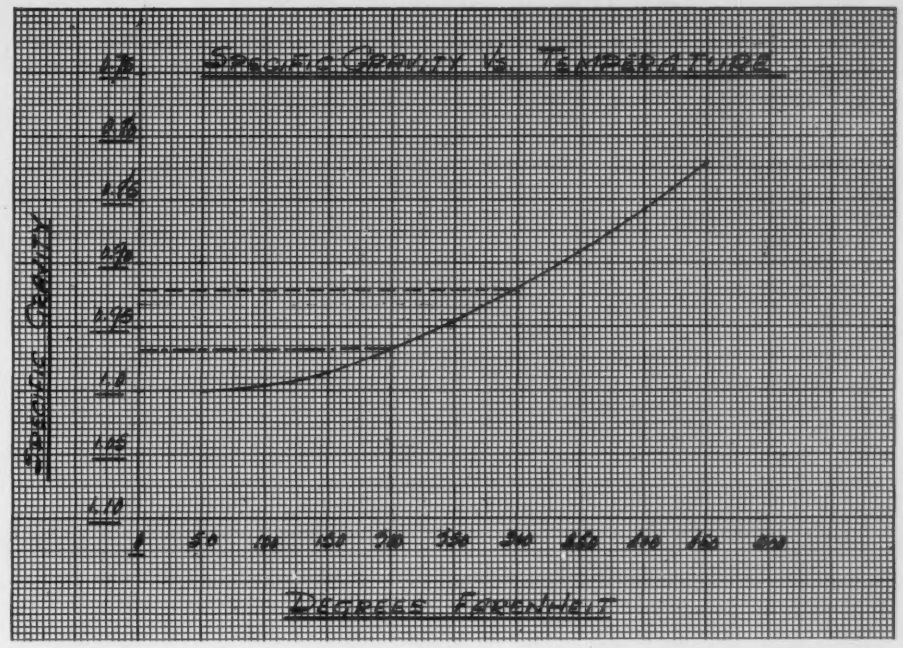


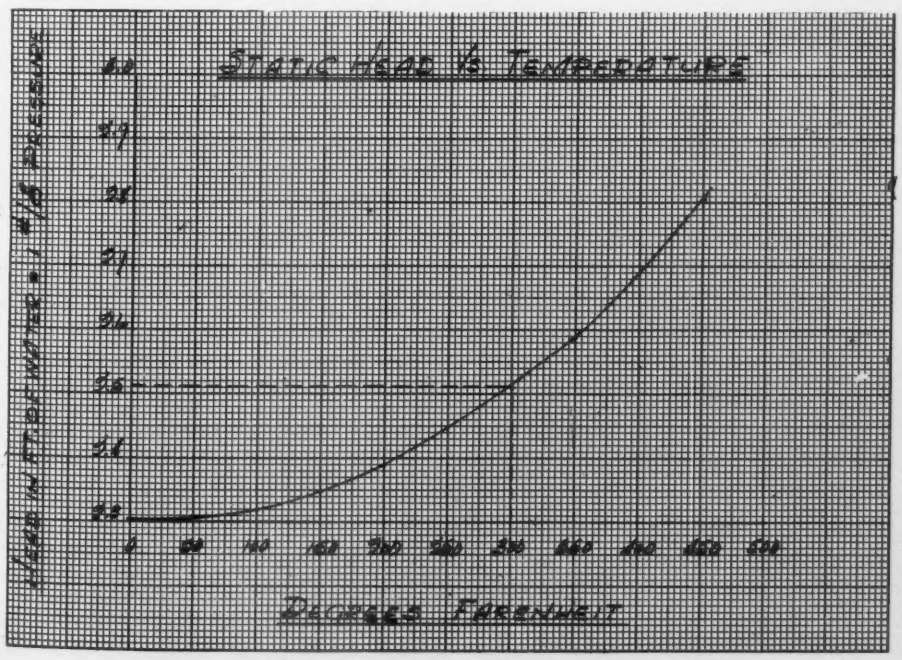
Figure 4

When heating water to 300° from a much lower temperature, its volume will expand and some means must be found to provide for this expansion. Assuming worst conditions, that is, water enters the system at 40° from an outside water supply when the system is first put into operation, the water will expand eight per cent of its original volume when heated to 300°. (See Figure 4.) The customary expansion tank placed at the highest point of the system will take care of this expansion without producing any undesirable stresses in any part of the system. Although the expansion tank may be placed at any convenient point in the system. it would be advisable to place it at the highest point, from an operating viewpoint. In this way the expansion tank not only absorbs any expansion of the water, but also serves as an air receiver for any air that might accumulate in the system. The air, because of its lighter density, will rise to the highest point of the system (into the expansion tank) and thereby will be expelled from the piping system.

A pressure relief valve should be installed on the expansion tank, set to relieve the pressure in the system should it go above an advisable limit. A drain connection from the expansion tank leading into the relief valve discharge line should be installed as an integral part of the piping system. A vent connection might also be provided in the expansion tank to remove any excess air that might accumulate at the high point of the system. This connection would be normally closed while the system is in operation.

After determining the *Gpm* required by each heat transfer unit, the piping system may be sized. As explained above, the static pressure at any given elevation is constant throughout the entire system; therefore the total head pressure against which the circulating pump must operate will be equal only to the friction head produced by the flow of water through the piping and equipment.

Figure 5



Boilers, heat exchangers, heat transfer units, piping, valves, and fittings all offer resistance to the flow of water, and the amount of water flowing through each is inversely proportional to the resistance offered. For each, a specific amount of friction must be allowed, and this summed up gives the total friction in any one line or in the entire piping system. Manufacturers of various pieces of equipment publish pressure drop information on their products expressed in lbs./sq. in., feet of water, or in milinches of friction head. Any of the three methods may be used to estimate friction head or may be converted over to either of the other two to simplify calculations.

Because the pressure drop in the entire system will be comparatively small, it would be advisable to use milinches of friction head for all

(*Continued on page 364*)

The Great Spiral Nebulae of Andromeda

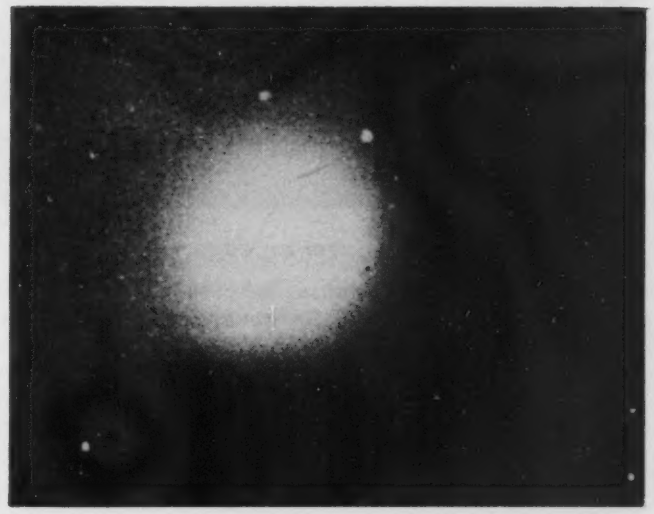
Dr. R. S. Underwood
"Astronomy, the Threefold Science"

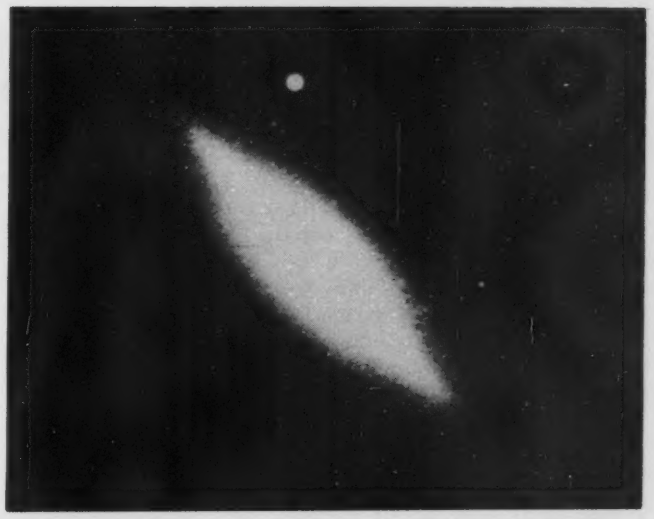
The Birth of the Stars

BY PETER B. NEIMAN, 2–48

LONG before the first man opened his eyes on earth; long before there ever was an earth; back in the days when stars, planets, and life itself were mere daydreams of some celestial power; back some ten million million years, the universe was starting life as a chaos of gas. The gas was similar to the ones with which we on earth are familiar, with one outstanding exception. It had a density so low that it is almost beyond conception. Ordinary air has a density of .08. Primeval gas had a density of about 1.5×10^{-30}. Molecules of ordinary air are .000008 inches apart; molecules of primeval gas were, on the average, three yards apart. Such was the universe in the beginning of time.

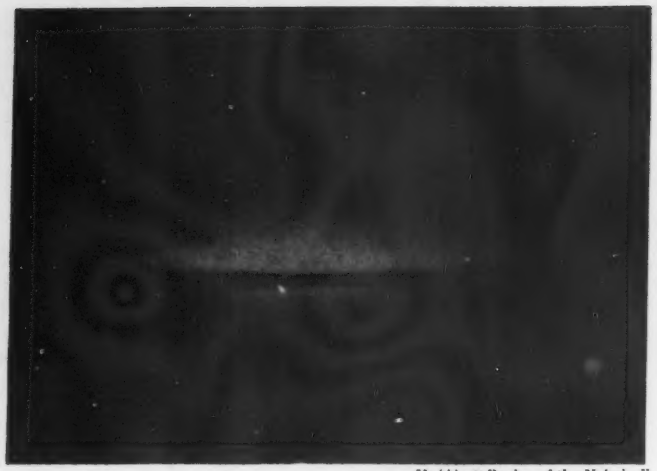
Before going any further, clap your hands. The sound produced is caused by collisions of air molecules. At the points of collision there is a greater concentration of matter in space than in the surrounding areas, causing a gravitational attraction of the surrounding molecules. In the case of sound, this is immediately neutralized by the opposing attraction of the earth. Suppose, now, that tiny disturbances, such as those made by the clap of your hands, were made in primeval space. Molecules would be sent rushing out in space. Every once in a while a molecule would collide with his neighbor. Since this primeval space was all low density gas, there would be no larger masses to inhibit the growth of these two molecules. They would combine and start to attract other molecules, so that condensations of gas would form in various parts of space. The attractive force between molecules, however, is extremely feeble, so that a large concentration of molecules would be necessary to continue attracting molecules. The size of such a concentration can be calculated, and at the extremely low density of primeval gas it





Nebulae starts off as a spherical mass of gas, undergoes calculated shapes, and emerges disintegrated into star masses (see text).

Hubble, "Realm of the Nebulae"



Hubble, "Realm of the Nebulae"

Spiral nebulae seen from an edge view

was found that a concentration of matter about 3500 million times that of the sun would be necessary. Any lower concentration would not attract more molecules, and therefore would not grow. In obedience to the laws of gravity, larger, increasing masses would attract and absorb the smaller, stagnant ones, until nothing but large ones remained.

So far, theory and fact fit beautifully, for masses as large as those calculated are known to exist. They are called nebulae, and are found to be made up of gas with a density of 5×10^{-22}. A few of them can be seen with the naked eye. If you will look in the northern sky on a clear night, about halfway between Beta Cassiopeia and the nearest corner of the Great Square of Pegasus, you will see a brilliant blur of light, somewhat larger than the surrounding stars. This is the Spiral Nebula of Andromeda, the most beautiful of all the nebulae. The size of Andromeda is so enormous that an electron, traveling at 500 miles a second, would take 19 million years to circle it once!

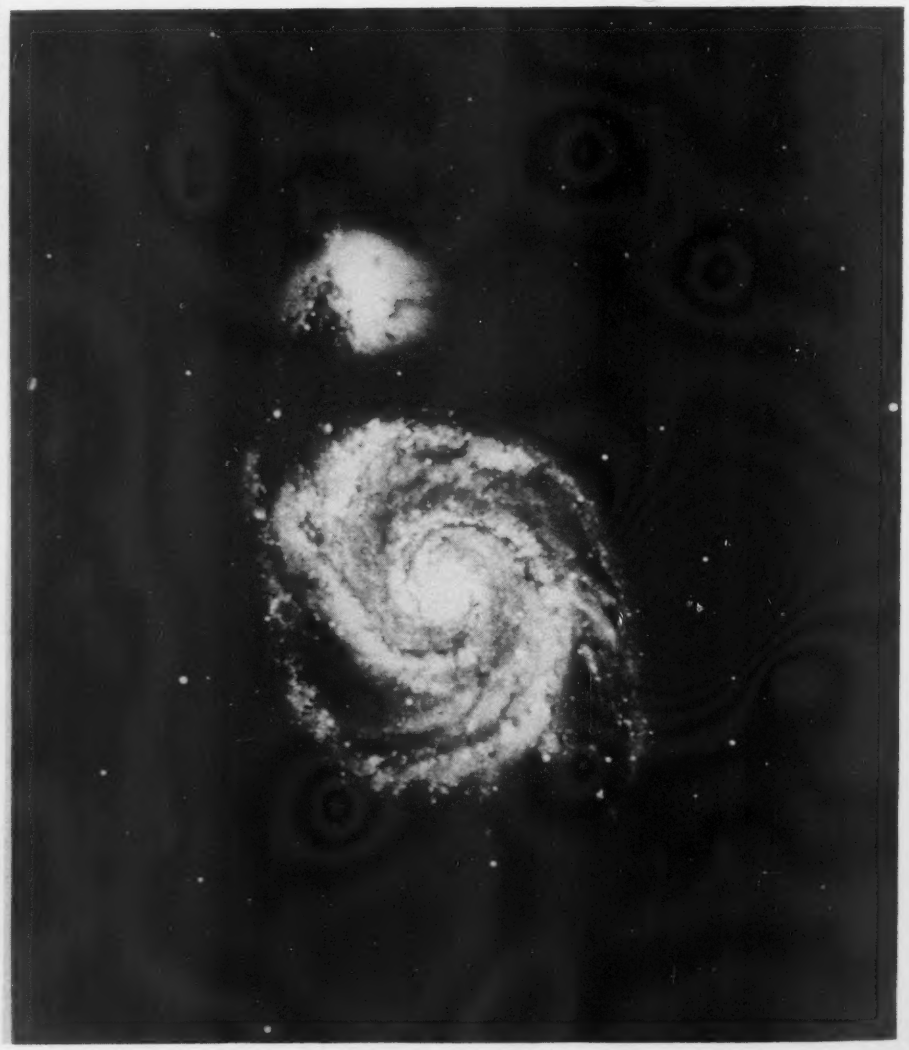
While a nebula is being formed. molecules are rushing into it from all directions and at all speeds. This causes the mass to accelerate angularly. In the meantime, the center of the nebula, having a greater density than the outer parts, begins to attract the outer molecules, so that the nebula contracts. Now mathematical calculations show that a rotating, contracting body of gas has to have certain distinct forms as it rotates. In the first place, it has to start off as a sphere. Slowly the sphere flattens out until it looks like a squashed orange, with a bulge around the middle. As the rotation increases, the body becomes flatter and flatter. and the bulge becomes larger and larger, until finally the body is shaped like an egg, fried sunny side up, with a small body cut in two by a flat circular plane. Once more fact and theory coincide, for nebulae have been photographed in every stage of rotation calculated.

At this stage of evolution, the contraction of nebulae plays a vital role; for as nebulae contract, they have to increase their angular motion in order to conserve angular momentum. As the speed increases, the momentum of the molecules also increases, until it gets great enough to overcome the force of gravity holding them together. Then gaseous molecules are ejected through the equatorial plane of the nebula in the form of spirals (hence the name "Spiral Nebulae"). This gaseous matter is similar to the primeval gas, only much denser (10×10^{-22}). As in the primeval gas, any small disturbance will cause condensations, only they will not have to be as large as the original nebula, for their density is greater than that of primeval gas. These lumps of matter can be seen in an ordinary telescope. The largest telescopes show that each of these lumps is made up of myriads of tiny pinpoints of light, which can only be stars.

This then was the pre-natal stage of our universe. In ten million million years it has come from a primeval chaotic universe, through gigantic nebulae, to an orderly array of stars and planets, out of which man, in the last micro tick of astronomical time, has emerged to explore the heavens and find out where he has been and where he may be going.

Another famous nebulae, the Whirlpool Nebulae in Canes Venatici

Mt. Wilson Observatory



Double Fluorides of Zirconium

By EDWIN J. BIELECKI, 2–46

Condensed

MANY of the "rarer" elements have found wide use in industry recently. Some of the mystery surrounding the less-commonly known (as differentiated from less-common) elements is due in part to the avoidal of their chemistry in elementary survey courses and in part to their former scarcity. One of these elements is zirconium.

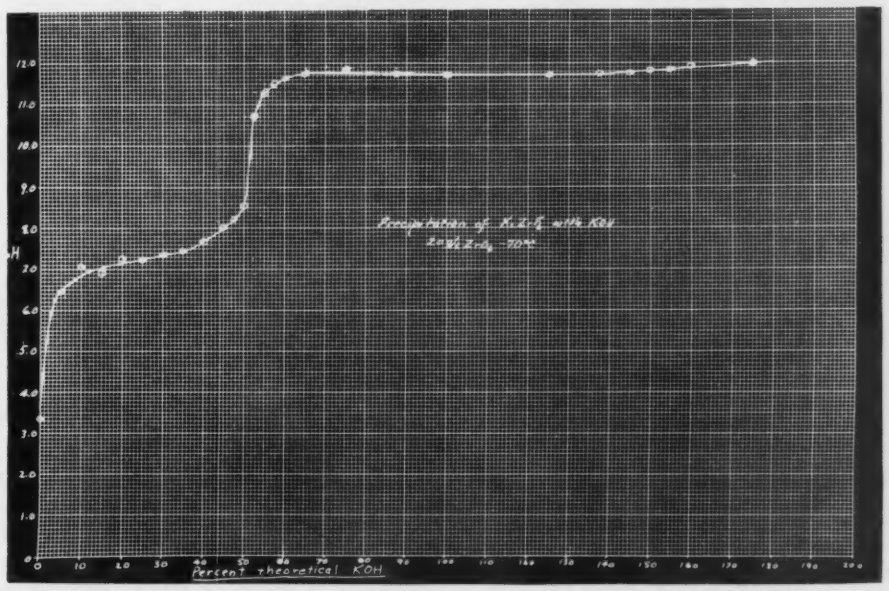
Zirconium has an atomic number of 40, and is in group IVa of the periodic table along with titanium, hafnium, and thorium. These elements form many similar compounds and one group which is of fundamental importance is the set of double compounds known as double fluorides. Zirconium preparations in the latter class have attained commercial importance during the war.

Many elements form double fluorides with zirconium. Compounds of lithium, ammonium, rubidium, caesium, thallium, copper, magnesium, zinc, cadmium, manganese. nickel, sodium, and potassium have been reported in the literature. These are usually prepared by adding a solution of either the metal fluoride or the zirconium fluoride to a solution of the fluoride of the other component, the order depending on the desired composition. For instance, when one part of thallium fluoride is added to three or four parts of zirconium fluoride in solution, and the resulting mixture cooled, $TlF.ZrF_4.H_2O$ will be formed: when zirconium fluoride is added to a solution of copper fluoride containing an excess of copper fluoride. $2CuF_2.ZrF_4.12H_2O$ is formed. The composition of these double fluorides is constant for a particular compound, but some elements form more than one compound with zirconium fluoride. As a rule, the formulas may be given as M_2ZrF_6 where M is one atom of a univalent metal, or one-half a divalent metal atom. Deviations from this formula can be considered to be molecular compounds with extra molecules of either constituent, although there does not seem to be a definite rule regarding formation (aside from coördination number).

The only important compounds for commercial and industrial use are the double fluorides of sodium and potassium. With the need for a double fluoride of zirconium established (as we shall see later), a choice had to be made between the sodium and potassium compounds. To all external appearances, the sodium was more desirable to make — the cost was lower and the raw materials were far more available than those necessary to manufacture the potassium compound. However, even though no trouble is encountered in a laboratory preparation of the sodium zirconium fluoride by simple mixing of solutions, the commercial scale process was of another type, requiring other properties in the products for successful completion. The plan was to adapt a process discovered by H. C. Kawecki for the preparation of a double fluoride of beryllium and sodium from beryl ore and sodium silicofluoride (Na_2SiF_6). The raw materials were sintered together and the sinter was extracted with water. For the zirconium compound, zirconium oxide (ore) was substituted for the beryl, and K_2SiF_6 substituted for Na_2SiF_6.

$$ZrO_2 + K_2SiF_6 \longrightarrow K_2ZrF_6 + SiO_2.$$

The leaching of the sinter was to be accomplished with hot water and the double fluoride isolated by cooling. The difficulty with the sodium compound seemed to lie in this last process. The potassium compound, however, proved superior and especially convenient from the standpoint of isolation by virtue of its solubility curve. The potassium silicofluoride for the operation was not available for preliminary work and had to be prepared in the laboratory of the Beryllium Corporation of Pennsylvania where most of this work has been done. With a 10 per cent excess of the silicofluoride and small amounts of potassium carbonate, yields were improved over an original 55 per cent. In fact, after leaching with a solution containing 20 ml H_2SO_4 and 20g KF per liter, results up to 97 per cent of the theoretical were obtained by the author. For commercial use, the KF was eliminated, the concentration of H_2SO_4 lowered, and KCl used in place of the K_2CO_3. The sinter is leached with boiling water and cooled to room temperature under varying conditions to obtain the potassium zirconium fluoride. The purpose of the variation in method of cooling is to effect a variation in the density of the resulting fluoride crystalline precipitate. It was also found that a mixture of KCl and Na_2SiF_6 used in place of K_2SiF_6 gave almost



Precipitation of K_2ZrF_6 with KOH — 20 grams per liter ZrO_3 — 70 degrees C.

(*Continued on page 376*)

Finite Geometry

By ROBERT P. ABELSON, 10–47

THEIR minds crammed as they are with data and formulae, engineers must surely fall victim to many wild nightmares peopled with mad scientists and technological hobgoblins. Frequently, I should imagine, the villain of the piece is a dreamy, babbling idiot called a "pure mathematician." This unfortunate personage never seems to have any success at plying his trade amongst engineers, for they all regard his achievements as useless and his sanity dubious. Although there may be some justification in the latter contention, I hereby cry out against the injustice of ignoring the benefits of pure mathematics. Discoveries in pure science invariably lead to advances in applied science. But what is perhaps equally important is the fact that pure mathematics affords a stimulus to creative imagination, and provides an infinitude of delightful and beautiful possibilities for an agile intellect. An appreciation of the abstract is a necessity for any intelligent person who does not wish to suffer out his life under the mouldy impression that only that which is physically realizable is worth while.

I do not seriously entertain the idea that finite geometry will be some day useful. (Although who can tell?) Rather, it is a refreshing novelty especially appealing to an original mind. The basic premise of finite geometry was conceived by two conjurors of weird geometries, Veblin and Young. To the best of my knowledge, all else that follows is entirely original to myself and my collaborator, one Lionel Jaffe, now a junior at Harvard. I have never been able to discover any literature on the subject, apart from an advanced treatise dealing with Galois fields which was overrun with very horrifying formulae that were quite over my head.

The important features of this "pure geometry" (one which is removed from physical experience) are (and remember these!):

1. Visualization is utterly impossible. Terms such as "triangle," "median," etc. which are defined analogously to their counterparts in Euclidean geometry do not thus become Euclidean entities. Finite geometry is an entirely new animal altogether. The fact that certain theorems occur which sound identical with everyday high-school geometry theorems is but one of the whimsical properties of finite geometry. Again: do not try and visualize anything which follows in terms of anything you have ever learned. You must start afresh from the definitions and axioms given.

2. Any assumptions whatever may be made to start out with, provided that the resultant system of theorems is not self-contradictory. Also, a certain number of undefined terms is an absolute necessity. (Try defining the well-known everyday "point" without chasing yourself in gigantic circles.)

3. Diagrams are a matter of convenience in keeping track of everything, but are utterly meaningless. All the diagrams I give here will utilize the actual "points" of my finite geometry to facilitate empirical verification of all theorems.

Now we are ready to begin. Firstly, we state that there are but a finite number of "points" upon any "line." (A "line" is a definite kind of collection of "points," to be clarified shortly.) This axiom represents a complete break with all other common geometries, in which there are an infinite number of points on a line.

Next we suppose that there are n "points" on any "line," n "lines" in any "plane" (a collection of "lines"), n "planes" in every "solid" (a collection of "planes"), n "solids" in every "hypersolid" (a collection of "solids"), and so on. Thus, where there are d dimensions (dimension is determined by the number of its subgroups; thus a hypersolid is of dimension four, since it contains solids containing planes containing lines containing points), the total number of points is n^d. As I shall demonstrate later, a necessary condition for a self-consistent finite geometry is that n be one more than some integral multiple of d, or, $n=ad+1$, where a is an integer. For our purposes, a two-dimensional, five-point per line set-up is best for a starter. Let us letter our 25 (5^2) points A through Y, and write them in a box, like this:

—*A*–	*B*–	*C*–	*D*–	*E* →	("Horizontal lines")
—*F*–	*G*–	*H*–	*I*–	*J* →	
—*K*–	*L*–	*M*–	*N*–	*O*–→	
—*P*–	*Q*–	*R*–	*S*–	*T* →	
—*U*–	*V*–	*W*–	*X*–	*Y* →	
↓	↓	↓	↓	↓	
("Vertical lines")					

We shall call collections of five points such as *ABCDE* horizontal lines, and collections of five points such as *AFKPU* vertical lines. We have thus established ten lines and soon we shall establish twenty more, but in general, any random collection of five points is not a line; only certain specific collections of five points are lines.

The box-like arrangement above is a sufficient basis upon which to build a finite geometry. However, it is greatly more convenient to represent this same box, or "plane," in two more ways. We will thus not establish two more planes, but will only be looking at our one plane in two distinct new fashions.

The reason for having three boxes (which we shall call "matrices" for the sake of dignity if nothing else) is to be able to axiomize the statement, "Two points determine a line." The matrices are as follows:

A B C D E	*A W T L I*	*A H O Q X*
F G H I J	*M J B X P*	*N P W E G*
K L M N O	*Y Q N F C*	*V D F M T*
P Q R S T	*G D U R O*	*J L S U C*
U V W X Y	*S K H E V*	*R Y B I K*

The concept of a "horizontal line" and a "vertical line" remains unchanged. (*AWTLI* is a horizontal line; *OWFSB* is a vertical line.) In the present set-up, every

pair of points will lie on one and only one line, either horizontal or vertical. In other words, "two points determine a line."

The next step is the definition of distance. I have found that the most satisfactory scheme is to consider distances along the vertical of a different nature than distances along the horizontal. Also, if two points have one or two points between them on their line, the distance between them is called two. If two points are adjacent or have three points between them on their line, the distance between them is one. (Imagine the points of a line to be arranged in a circle.) We have now defined four different distances: one horizontal, like *PQ* or *RK*; two horizontal, like *LN* or *GR*; one vertical, like *AN* or *TH*; and two vertical, like *GV* and *DY*.

With these first fundamentals, we are ready to begin exploration of the various fields of geometry. Because of the whimsical method of proof and the delightfulness of the result, I shall give here the basis and proof of a theorem analogous to the Euclidean statement, "The medians of a triangle meet in a point."

Prepare for a barrage of definitions, axioms, and theorems, setting the stage for the piquant denouement!:

DEFINITION 1: Parallel lines are lines with no common point.

DEFINITION 2: Perpendicular lines are lines appearing in the same matrix which are not parallel.

AXIOM 1: A line perpendicular to one of two parallel lines is perpendicular to the other.

AXIOM 2: Parallel lines are everywhere equidistant. (If the distance is measured along the perpendiculars.)

DEFINITION 3: A triangle consists of three points (vertices) and the lines between them (sides).

DEFINITION 4: Congruent triangles are triangles the distances between whose vertices are respectively identical.

DEFINITION 5: Two lines are of the same sense if they are both horizontal or both vertical.

AXIOM 3: Triangles, each with two perpendicular sides (right triangles), are congruent if the distance between the vertices away from the perpendicularity (right angle) of one corresponds to the distance between the analogous vertices (the hypotenuse) of the other.

AXIOM 4: Two right triangles are congruent if one of the sides of one (not the hypotenuse) is equal (has the identical distance between vertices) to the corresponding side of the other, and the remaining sides are correspondingly of the same sense.

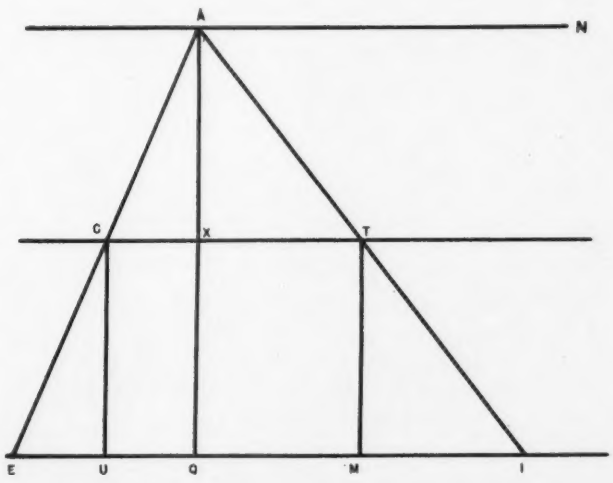
DEFINITION 6: The mid-point of two points is the point on their line which is equidistant from them.

AXIOM 5: Two points can have one and only one mid-point.

AXIOM 6: Of any three points on a line, one must be the mid-point of the other two.

AXIOM 7: On a line, a point cannot be equidistant from three other points.

Theorem 1: If three parallel lines "cut off" equal distances on one line, then they do so on all lines.



Given: $AN \parallel CT \parallel EI$
$AC = CE$

Added: $AQ \perp EI$
$AQ \perp CT$ at X
$CU \perp EI$
$TM \perp EI$

Prove: $AT = TI$

1. $\triangle ACX \cong \triangle CEU$	1. $AC = CE$; $AX \perp CX$; $CU \perp EU$. AXIOM 3
2. $AX = CU$	2. DEFINITION 4
3. $CU = TM$	3. AXIOM 2
4. $AX = TM$	4. Things equal to the same thing are equal to each other
5. XT is of the same sense as IM	5. Parallel lines are of the same sense
6. AT is of the same sense as TI	6. AT and TI are parts of the same line
7. $\triangle AXT \cong \triangle TMI$	7. AXIOM 4
8. $AT = TI$	8. DEFINITION 4

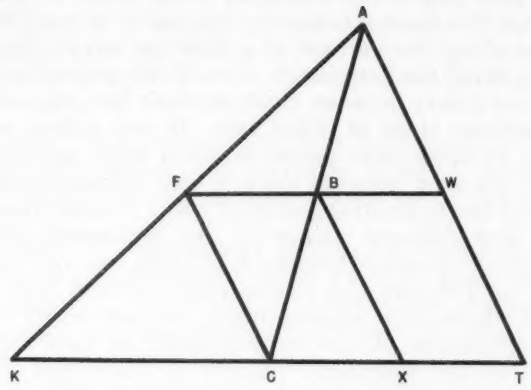
Theorem 2: The lines joining the mid-points of two sides of a triangle is parallel to the third side. (This is a natural corollary to Theorem 1; since the line through the mid-point of one side, parallel to the "base," must divide the opposite side into two equal parts, and only one line can pass through the two mid-points, the line parallel to the base must be that line.)

Theorem 3: The line joining one vertex of a triangle with the mid-point of the opposite side passes through the mid-point of the line joining the mid-points of the other two sides.

Given: $AF=FK$
$AW=WT$
$KC=CT$

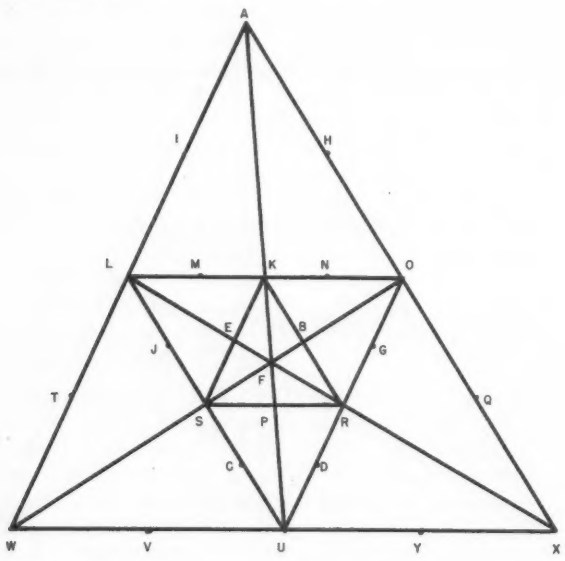
Added: $FC \parallel AT$ (*Theorem 2*)
$BX \parallel FC$

Prove: $FB=BW$



1. Either $FB=BW$; $FW=WB$; or $BF=FW$ — 1. Axiom 6
2. If $BF=FW$, $XC=CT$ — 2. *Theorem 1*
3. But $KC=CT$ — 3. Given
4. $BF \neq FW$ — 4. The point C cannot be equidistant from all three points, K, T, and X. (Axiom 7)
5. $BW \neq FW$ — 5. Similar reasoning
6. $FB=BW$ — 6. Only remaining possibility

Theorem 4: The lines from the vertices of a triangle to the mid-points of the opposite sides (medians) meet in a point.



Given $AO=OX$
$AL=LW$
$WU=UX$

Added: $LO \parallel WX$, $LU \parallel AX$, $OU \parallel AW$ (*Theorem 2*)
$SK \parallel OU$, $KR \parallel LU$, $SR \parallel LO$

$LK=KO$, $LS=SU$, $UR=RO$, $SE=EK$, $SP=PR$, $KB=BR$ (Axiom 5)

AU passes through K (*Theorem 3*)
UK passes through P (*Theorem 3*)
Similarly for lines $LERX$ and $WSBO$
Prove: AU, WO, and LX all pass through the same point (F)

---

1. Triangle AWX is composed of twelve distinct points: A, H, O, Q, X, Y, U, V, W, T, L, I. — 1. A triangle is composed of three lines (fifteen points). But the three vertices are each common to two lines. Thus twelve points.
2. Triangle LOU is composed of nine more distinct points: J, S, C, D, R, G, N, K, M. — 2. Every triangle is composed of twelve points. But three (L, O, U) already have been considered in triangle AWX. Furthermore, no point on any side of triangle LOU (take LU as an example) can lie on triangle AWX. (LU is parallel to AX, and any point common to LU and either LW or WV would violate the inviolable "Two points determine a line.")
3. Triangle KSR consists of three more distinct points: E, B, P. — 3. Similar reasoning to step 2. (Points Q, R, S, T, I, K, Y, H, and V.)

(*Continued on page 366*)

Ion Exchange Resins

Part II

By KENNETH WIBERG, 2–48

IN a previous article (April 1946), the ion exchange process was discussed. The purpose of this article will be to show some of the many varied and important uses of these materials, and also to indicate the methods by which the process may be carried out.

The most common and most popular method of operation is the "column method." This method is particularly convenient because it is a continuous process, is readily controlled, and in general is more efficient in the removal of ions than is the "batch" process. In a static system, such as the batch process, a definite end point is reached at which there is a finite quantity of all involved ions present in the solution being treated. In the column method of operation, a dynamic system, the countercurrent principle is effective in that the concentration of the ions in the solution passing down through the resin is being constantly decreased, and in effect is constantly being brought into contact with fresh exchanger. Thus there is no possibility for an equilibrium to be set up, and ion removal is for all practical purposes complete. This very real advantage, coupled with the obvious mechanical advantages, has led to a widespread use of the column technique.

A typical laboratory column set-up is shown in Figure 1. The basic principles of column operation as applied to the laboratory case are the same as used on a pilot plant or full commercial scale, and it has been found that data obtained from laboratory column tests can be readily translated to larger scale operations. Thus the suitability of these materials for a certain process can be readily determined in the laboratory with a minimum of labor and expense.

Although the column method of operation is generally employed, the batch process has often been found to be convenient for special processing problems. The main advantages of this method are: (1) it is a much simpler method of operation, the exchanger being added to the solution, which is then thoroughly stirred and decanted or filtered from the resin; (2) in most cases the batch process does not necessitate the obtaining of new equipment, and (3) this process is especially adaptable to viscous solutions which will not readily pass down the column.

As far as the uses of these versatile materials are concerned, the process lends itself to ten main unit processes. Although many other uses are known, the following are the ones which are commercially important at this time. In the near future it is expected that new processes will be found to be economically feasible, but this discussion will be mainly limited to the present uses.

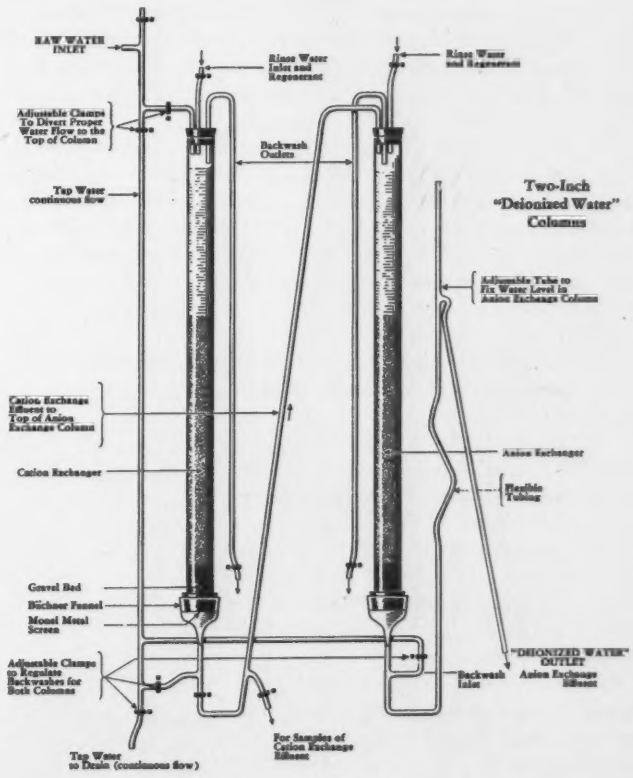
1. Reduction of hardness: In applications where this is the main necessity, the cation exchanger is used in the form of the sodium salt. In some applications, such as use in laundries, home units, ice plants, hotels, and the like, it is very desirable to remove stain-producing impurities such as iron and manganese in addition to the hardness-producing salts. The ion-exchange resins are, therefore, doubly suited to such applications, since they remove these objectionable cations as well as calcium and magnesium ions.

2. Reduction of bicarbonate alkalinity: This can be accomplished by two general methods: (*a*) by blending of water treated by hydrogen exchanger with raw water, and (*b*) by blending of water treated with hydrogen exchanger with water which has been treated with a sodium exchanger. The principle of both methods is the same and depends upon the formation of carbonic acid by the reaction of the free acids formed by passage through the hydrogen exchanger with the carbonates or bicarbonates of raw, or sodium-exchanger-treated water. Aeration removes the carbonic acid thus formed.

This process is of especial importance since alkalinity in ice manufacture results in "snowy" ice, and excess alkalinity in boiler-feed water contributes to the embrittlement of exposed boiler parts.

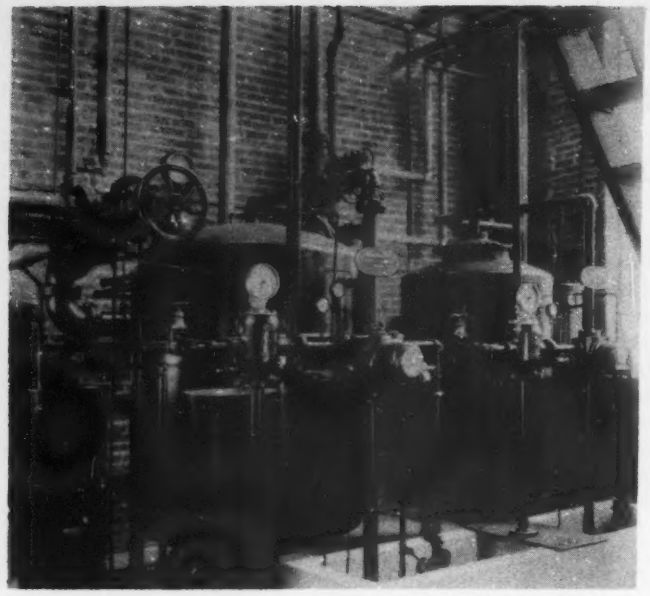
3. Reduction of total solids in water: This is perhaps the most important single phase of the ion exchange process. In this process, the raw water is put through the double cycle — the hydrogen cycle and the anion adsorbant cycle, followed in many cases with aeration in order to remove CO_2.

Two-inch "deionized water" columns


RAW WATER INLET
Rinse Water Inlet and Regenerant
Rinse Water and Regenerant
Adjustable Clamps To Direct Proper Water Flow to the Top of Column
Backwash Outlets
Tap Water continuous flow
Two-Inch "Deionized Water" Columns
Adjustable Tube to Fix Water Level in Anion Exchange Column
Cation Exchange Effluent to Top of Anion Exchange Column
Anion Exchanger
Cation Exchanger
Flexible Tubing
Gravel Bed
Büchner Funnel
Monel Metal Screen
"DEIONIZED WATER" OUTLET Anion Exchange Effluent
Adjustable Clamps to Regulate Backwashes for Both Columns
Backwash Inlet
For Samples of Cation Exchange Effluent
Tap Water to Drain (continuous flow)

A large amount of mineral matter in ice causes uneven freezing and a high concentration of solids in high pressure boiler feed waters causes increased hazards of scale formation and necessitates excessive blowdowns. These exchangers also offer an excellent method of removing the ammonium ion.

The results obtained with installations of combined cation and anion exchangers compare favorably with



The Permutit Company

An automatic zeolite water softener installed in a large Southern laundry

those previously obtainable only by distillation. Their use offers a means of obtaining very pure water for use in pharmaceutical preparations, the washing of precipitates diluting and blending, etc., with the additional advantage that the water is, of necessity, free from iron and oil, and thus it is often superior to available condensate supplies.

4. Conversion of salts by double decomposition: The application of this process to the chemical industries is obvious. In many cases it provides a means by which heavy metal salts can be exchanged by sodium, hydrogen, or under other circumstances by potassium and possibly ammonium. The reverse process is of course possible, by using a high concentration of the sodium salt, and a resin which has been "saturated" with the heavy metal. Unfortunately conversion is very poor, and this method has little practical value.

5. Removal of iron, copper, and other harmful cations: In this connection it should be remembered that the resins, as ordinarily used in the sodium cycle, will remove all cations except sodium and potassium. If a separation of ions is desired, a special operative technique must be used.

6. Recovery of valuable elements from aqueous solution: This process has found wide use in the recovery of copper from rayon mill wastes, cobalt, nickel and other ions from mine waters, and gold and cyanide from industrial wastes.

The use of ion exchange resins for the recovery of valuable ions present in minute quantities in certain chemical wastes offers a method of recovering materials which could not be obtained by any other technique. Simple regeneration of the exchanger beds is usually the method employed to recover these materials from the resins. In many cases, ores may contain metals which, although they could be extracted, could not be easily removed from the extract. Metal-containing industrial wastes which are at present an actual annoyance may thus become a source of revenue.

When the recovery of more valuable metals is considered, still another method of purification becomes feasible. The resin exchanger may be used to remove the metallic ion until it is depleted, and then could be ashed to recover the metal as such, as the oxide, or as the sulfide and oxide combined. The ion exchangers can usually be completely ashed.

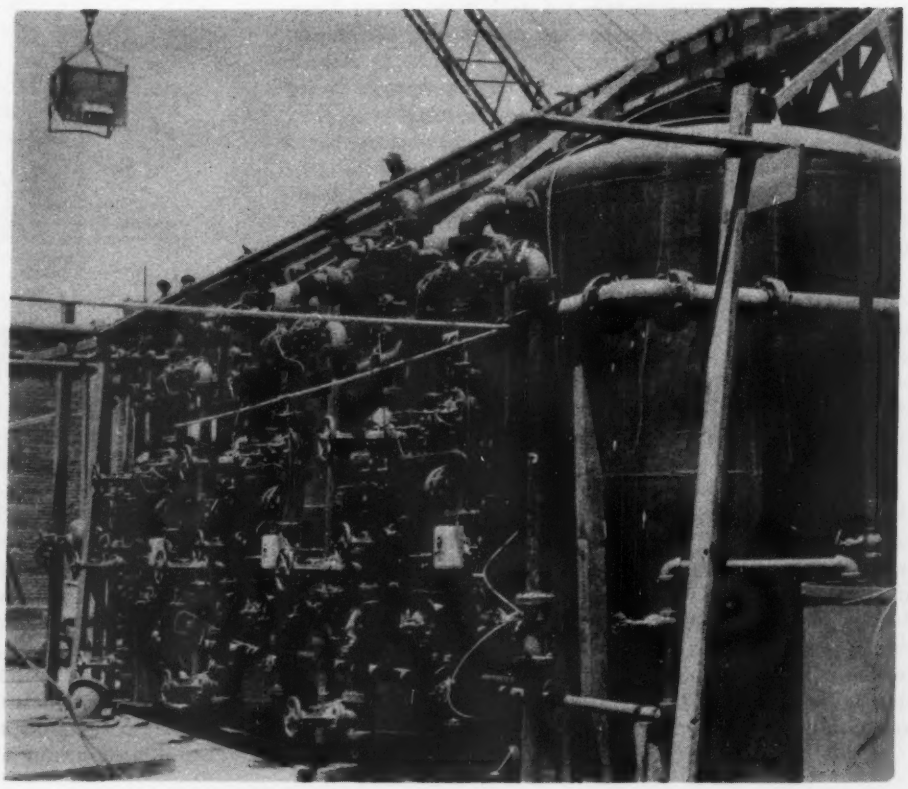
7. Removal of electrolytes from solutions of non-electrolytes: This is perhaps the most interesting application from the purely chemical standpoint. It has always been difficult to remove these materials from organic compounds because of the instability of many of these compounds to heat, light, air, etc. These materials are peculiarly adaptable to this process in that the reaction can be carried out without heat, in the absence of light, and precautions can be easily taken to minimize air oxidation.

The presence of small amounts of electrolytic impurities in aqueous solution of organic materials is often objectionable, and in effecting their removal difficulties may be encountered. Resinous exchangers offer an excellent method of removing the foreign materials, employing any of the following procedures:

(*a*) Use of cation exchangers as sodium salts. This system will remove ions other than sodium and potassium, in general will not decrease the total solids content, and will not appreciably affect the pH. The objectionable ion or ions would be replaced by an equivalent amount of sodium ion.

(*b*) Use of the cation exchangers as hydrogen derivatives. This system will remove all metal ions, replacing them with hydrogen ion, thus decreasing the pH considerably. Where high acidity in the effluent

(*Continued on page 372*)



Duplex deionizing unit — 600 gallons per minute. Installed in a large Southwestern war plant, the water was used to quench rolled and extruded aluminum shapes. *Illinois Water Treatment Co.*

TURBO ENCABULATOR

EDITOR'S NOTE: *For nearly twenty years the "Industrial Bulletin" of Arthur D. Little, Inc. has endeavored to interpret scientific information in terms that the layman could understand. The present contribution is, however, of such basic significance to scientific thought as well as to industrial progress, that the company thought it best to print it without delay for the benefit of those specialists who could fully appreciate its precise terminology. Perhaps one of these specialists will later offer a more general interpretation.*

In this same spirit of scientific expediency we here reprint the original paper exactly as it was first presented. We regret that, despite the relaxation of wartime security regulations with their attendant hazards, the authors of this paper have preferred to remain anonymous.

For a number of years now work has been proceeding in order to bring perfection to the crudely conceived idea of a machine that would not only supply inverse reactive current for use in unilateral phase detractors, but would also be capable of automatically synchronizing cardinal grammeters. Such a machine is the "Turbo-Encabulator." Basically, the only new principle involved is that instead of power being generated by the relative motion of conductors and fluxes, it is produced by the modial interaction of magneto-reluctance and capacitive directance.

The original machine had a base-plate of prefabulated amulite, surmounted by a malleable logarithmic casing in such a way that the two spurving bearings were in a direct line with the pentametric fan. The latter consisted simply of six hydrocoptic marzelvanes, so fitted to the ambifacient lunar waneshaft that side fumbling was effectively prevented. The main winding was of the normal lotus-o-delta type placed in panendermic semi-boloid slots in the stator, every seventh conductor being connected by a non-reversible tremie pipe to the differential girdlespring on the "up" end of the grammeters.

Forty-one manestically spaced grouting brushes were arranged to feed into the rotor slip-stream a mixture of high *S*-value phenylhydrobenzamine and five per cent reminative tetryliodohexamine. Both of these liquids have specific pericosities given by $P=2.5C_n^{6.7}$ where n is the diathetical evolute of retrograde temperature phase disposition and C is Cholmondeley's annual grillage coefficient. Initially, n was measured with the aid of a metapolar refractive pilfrometer (for a description of this ingenious instrument, see L. E. Rumpelverstein in "Zeitschrift für Elektrotechnistatischs-Donnerblitze," vol. vii), but up to the present date nothing has been found to equal the transcendental hopper dadoscope. (See "Proceedings of the Peruvian Academy of Skatological Sciences," June, 1914.)

Electrical engineers will appreciate the difficulty of nubing together a regurgitative purwell and a supramitive wennelsproket. Indeed, this proved to be a stumbling block to further development until, in 1942, it was found that the use of anhydrous nangling pins enabled a kryptonastic bolling shim to be tankered.

The early attempts to construct a sufficiently robust spiral decommutator failed largely because of a lack of appreciation of the large quasi-piestic stresses in the gremlin studs; the latter were specially designed to hold the roffit bars to the spamshaft. When, however, it was discovered that wending could be prevented by a simple addition to the living sockets almost perfect running was secured.

The operating point is maintained as near as possible to the h.f. rem peak by constantly fromaging the bitumogenous spandrels. This is a distinct advance on the standard nivelsheave in that no dramcock oil is required after the phase detractors have remissed.

Undoubtedly, the turbo-encabulator has now reached a very high level of technical development. It has been successfully used for operating nofer trunnions. In addition, whenever a barescent skor motion is required, it may be employed in conjunction with a drawn reciprocating dingle arm to reduce sinusoidal depleneration.

SKYC

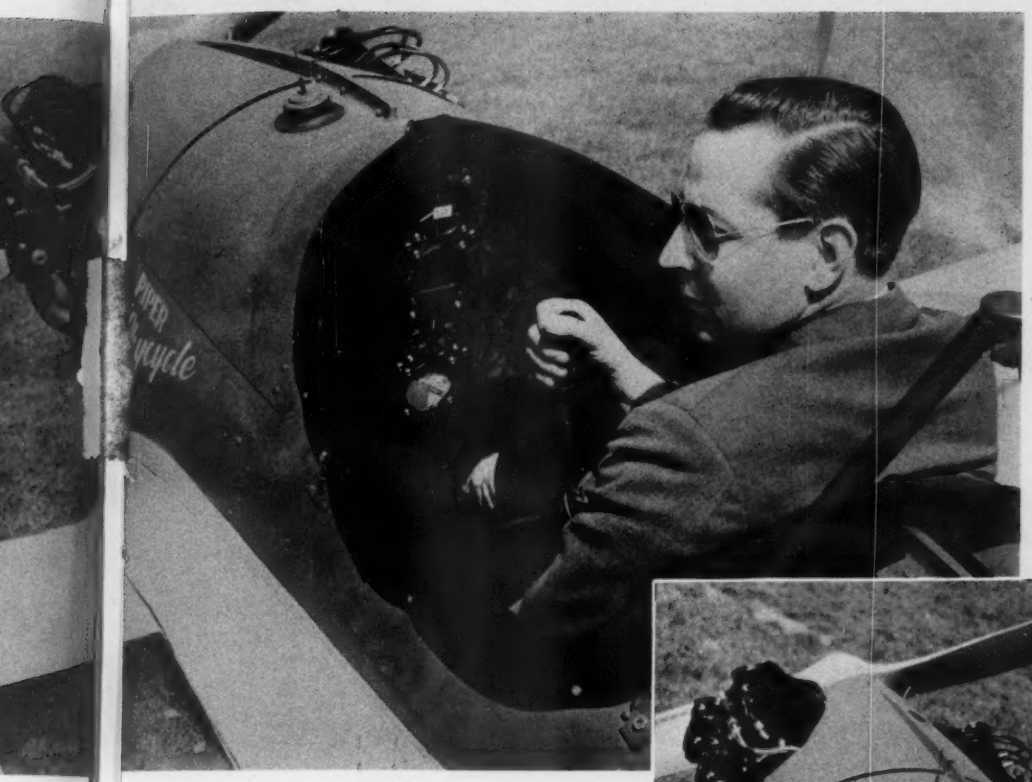
Born of the need for a salesman's runabout, the Piper Skycycle combines safety, low cost of operation, and performance into a neat little airplane.

The original test model of the PA-8, the company designation for the Skycycle, built during the war, had as its fuselage a detachable fuel tank of a Vought F4U Corsair. The 16-foot-long plastic fuselage in use now, fitted with a plexiglass bubble providing excellent visibility, is attached to the tail surfaces and a full cantilever 20-foot-span wing. A 55 h.p. Lycoming engine pulls the Skycycle through the air at 115 m.p.h. With a 14-gallon fuel capacity the craft has a range of over 400 miles — 32 miles per gallon! With its low landing speed, good inherent stability, and wide-tread landing gear to prevent ground-looping, the Skycycle is truly a pilot's airplane, and by virtue of its economy, a flying salesman's airplane.

G. J. F.

Right: Only 16 feet long, the fuselage appears overly small compared to the pilot it contains

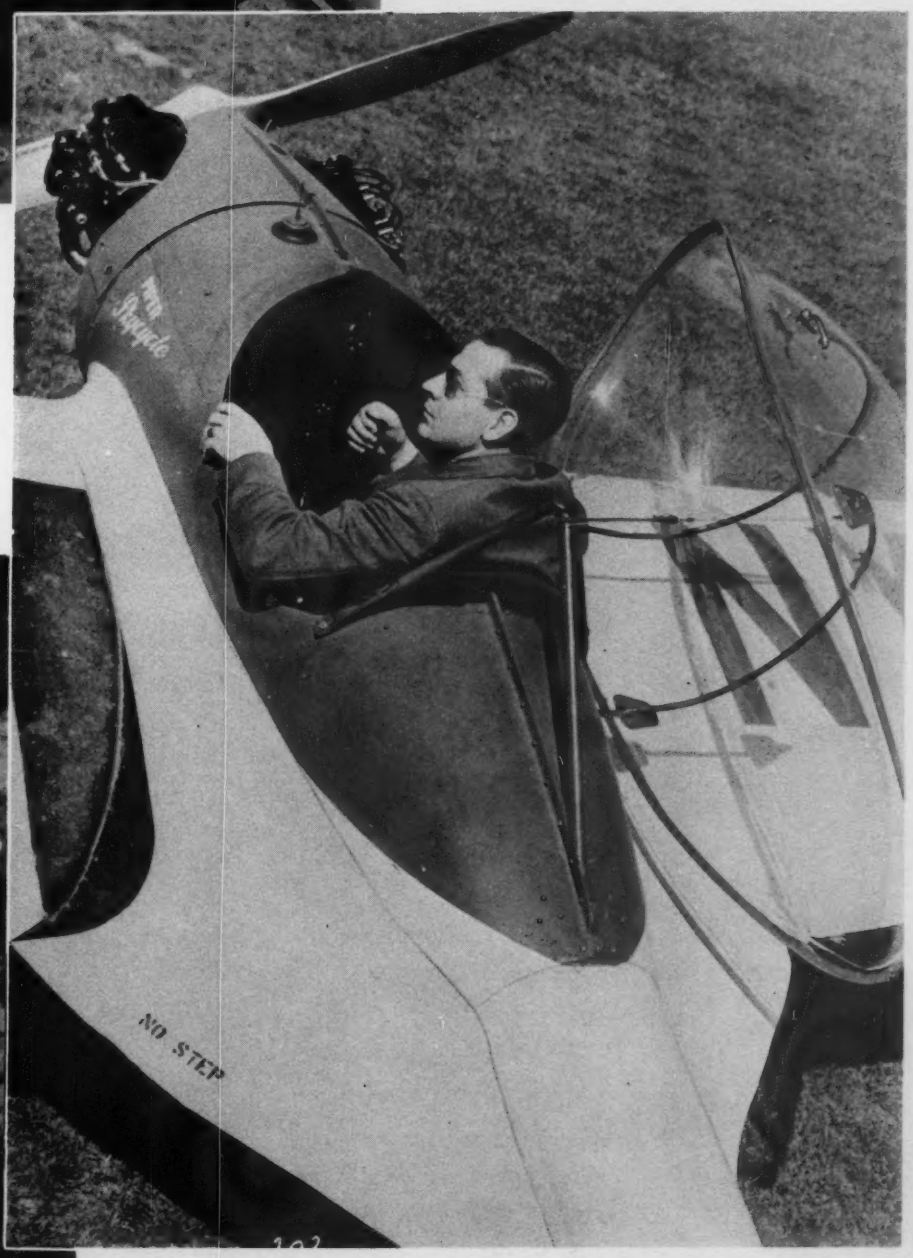
Far Right: The large plastic canopy provides a maximum of visibility along with a minimum of difficulty in entrance and exit



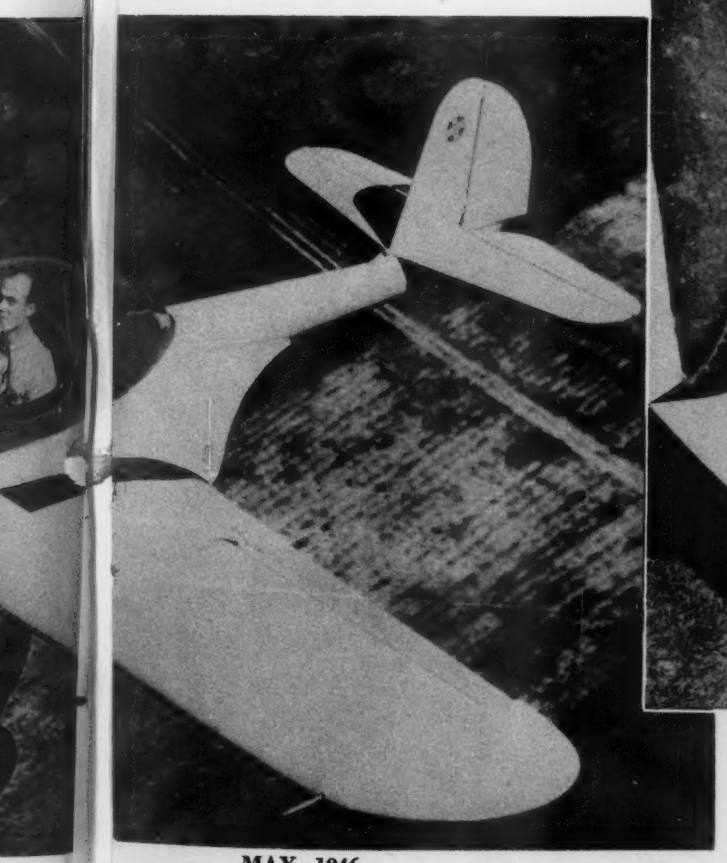
Left: Only the simplest flight and engine instruments are necessary.

Far Left: An underneath view of the craft in flight. Note the absence of landing flaps

All photographs courtesy Piper Aircraft Corporation



CYCLE



NXA7Y

The "Skycycle" in flight
Piper Aircraft Corporation

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Can You Do It?

THE THIRD IN A SERIES OF MONTHLY BRAINBUSTERS

This month: Pennies, pennies . . .

Problem 1: You are given a sensitive balance and a stack of a hundred and twenty pennies. You are told that the stack contains one defective penny that is either heavier or lighter than the rest. You are given no weights, so that all weighing is done by balancing penny against penny, or stacks of pennies against other stacks. One weighing consists of balancing one penny (or stack) against one other penny (or stack). You are allowed to make only five weighings but are allowed to mark pennies if you wish. Can you devise a method whereby you will always be able to separate the defective penny in the required number of weighings and tell whether it is lighter or heavier? It's possible! !

Problem 2: This time you are playing a game involving a hexagonal table of finite dimensions. The table has a circular hole cut in its center, the diameter of the hole being the diameter of a penny times the square-root of two. Both you and your opponent are given an inexhaustible supply of pennies and alternate at placing single pennies on the table — anywhere you desire. The game is to try to be the person to put the last penny on the table. Pennies must not be stacked one on the other, but must lie flat on the table itself. Pennies that fall off the edges of the table (or through the hole) do not count. Once a penny is placed on the table it may not be moved. If your opponent places the first penny on the table, what can you do so that you are sure of placing the last penny?

(*Answers to these and last month's problems are on page 378*)

The Dragon's Den

Self-Portrait . . .

This is the last issue of volume twenty-seven of THE TECH ENGINEERING NEWS. It concludes a year of publication that saw the beginning of postwar reconversion at the Institute and foresaw the reappearance of more stable times around the magazine office. Wartime staffs have been plagued by the continual turnover of men due to Selective Service and by the difficulty in getting material for articles, paper for print, and sufficient interest among the student body.

Normal times are once more in the offing, and many of these problems show promise of disappearing. Nevertheless, peace is not without its difficulties. With plans under way to reëstablish *T. E. N.* at its peacetime level of activity, it might be a good idea to take a careful look at *T. E. N.* and the conditions under which it operates.

As the Professional Journal of the Undergraduates at M. I. T., *T. E. N.* is probably the best known of Technology's publications outside of the Institute. The other magazines and papers — *The Tech*, the weekly; *Voo Doo*, the supposedly-comic monthly; *Technique*, the yearbook; and *The Technology Review*, the professional, alumni magazine — are all primarily intended for the various parts of the Institute family, while *T. E. N.* is known both in Tech and throughout the country in other colleges, in high schools, and in industry. It is probably Technology's closest connection with prospective students in preparatory schools all over the nation. As a member and founder of the Engineering College Magazines Associated, it comes into intimate contact with many of the publications produced at other institutions. And it is particularly when *T. E. N.* is compared to the great majority of these other magazines that the peculiar environment in which it operates becomes most evident.

Like all activities at the Institute, *T. E. N.* has a difficult time convincing its members that they can afford to put working hours into extra curricular activity. With the unusually heavy load of homework that each man receives at the Institute, time is at a premium, and, consequently, any outside interests suffer. *T. E. N.*'s staff has always been small compared to the national standard because of this factor.

Secondly, magazine sales around the Institute are quite small. Like carrying coals to Lewis. *T. E. N.* is trying to sell engineering to engineers. Outside circulation is somewhat better, but still is nothing to shout about.

Probably the greatest difficulty encountered, however, is Institute policy. Unlike almost every other college magazine, *T. E. N.* is given no actual recognition by the Institute and is placed quite low on the news priority list whenever any item of interest is released for publication. This lack of recognition often makes it difficult or impossible to obtain articles from members of the Institute staff, although many people have been exceedingly coöperative on a voluntary basis.

Lastly — and probably most disastrous — *T. E. N.* is completely independent financially. Without any form of school subsidy, besides a small special mailing-list, which is rarely paid for, *T. E. N.* is completely on its own. Furthermore, Institute Committee rules prevent any member of the staff from making any direct profit whatever from his association with the magazine; all profits revert to a "sinking fund" that is placed aside for rainy days.

All in all, while the lack of financial incentive may make the procurement of a large staff that will really work a total impossibility, the lack of official recognition — financial and otherwise — leaves the magazine to operate on its own, only nominally connected to the Institute at all. Yes, this editorial could be called a cry against an injustice. For while we on the staff labor to put out a publication that Tech will be proud of and that will further enhance the Institute's high reputation, we are snubbed within our own gates! Comparison with other schools will show that such a situation does not exist elsewhere to anywhere near the same extent. Even the Publications Council that governs all the undergraduate papers is but a nebulous figment of some organizer's imagination — leaving all of Tech's undergraduate publications in the same pit of neglect. In the coming peacetime world, Tech should be represented by the finest set of papers and magazines of any school in America. But such representation takes coöperation from the item being represented. How about it? When volume twenty-eight begins in the fall, can we look forward to increased recognition and coöperation so that we can give a good showing when compared to other schools? Do we get a fair break?

J. W. W.

The Pillory

Know all ye readers that the following persons have been convicted of being on the staff of that magazine known as The Tech Engineering News, and for that rank offense they are hereby sentenced to a one month stand in the public pillory.

John W. Weil, '48

The other evening a handful of previously sane Tech men were caught unawares by a tall, gangling apparition stalking down a dormitory hallway. This apparition was holding a pipe resembling a miniature Turkish hookah upside down in its mouth and was nonchalantly pouring cokes from an empty bottle. At the approach of the unbelieving Tech men, the apparition produced a saber and an issue of *T. E. N.* from under its cloak and proceeded to hack at the magazine, crying in anguish, "Not enough pictures! Not enough material, do you hear me! Aaaa-aagh!"

This was too much for the startled observers. They recoiled in terror. This apparition was highly unusual. This was John W. Weil.

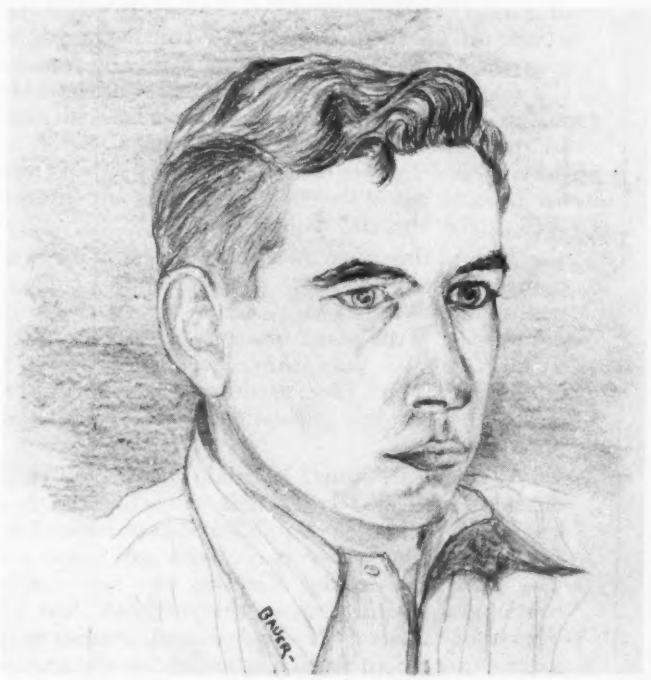
John W. entered Hell a year ago last March. Soon after Freshman Camp, while on a sight-seeing tour of the buildings, his youthful ears evidently confused "up" and "yup," so that when he asked whether Pritchett Hall was downstairs, and was told, "Up!" he proceeded downstairs, whence he became slightly confused. He courageously explored the subterranean passages like the veteran patronizer of the New York subway system that he was, but his search for Pritchett Hall was obviously in vain.

Two places, however, caught his interest. One was the 5:15 Club and the other was a place with a sign outside reading "T. E. N." Now John is a tall fellow — even in his stocking feet he would put a six-foot ruler to shame — who must have gotten that way because he has always striven for higher things. Comparing the two points of interest, 5:15 and 10, he, of course, headed immediately for the latter. Inside the sacred

(*Continued on page 384*)

Peter E. Piccoli, '48

Pete Piccoli is the guy who "makes up" *T. E. N.* In case you didn't know it, the make-up editor is the beast of burden whom the rest of the staff inevitably cause untold misery by requiring a complete rehashing of the issue on the night before finished copy must be delivered to the printer. This has been going on for four months. Before that, he used to count words for the previous make-up editor on the famous third floor of Hayden.



Pete is one of those poor brown-baggers in Course VI, although you'd never know it by looking at the wiring job he's done on his room. However, we suspect that there's a bit of method in his madness, for he probably figures that mice will be kept from investigating the mysteries of his vast store of groceries by the fear of being electrocuted. Speaking of his larder, any night around one o'clock you can find a bunch of guys in his room tucking away one of his real spaghetti dinners, complete with coffee and maybe fried pepper sandwiches.

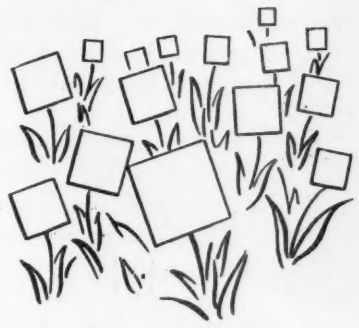
From the outside, Pete's room is readily distinguishable because of the ominous blue glow emanating from the specially imported blue lantern which he had shipped all the way from his home town. Those who know him realize that the blue one is merely a poor substitute for the green lantern for which he has been vainly searching ever since he's been at Tech to glare defiantly back at all the seductive red lanterns which nightly light up the Dorms.

Pic finds lustful pleasure in listening to Sentimental Journey and in dreaming of one M. C. with whom he used to wander through the halls of East Side High back in Paterson, N. J. Often he may be found forcing pennies

(*Continued on page 384*)

NUMBER 3 OF A SERIES

Newsworthy Notes for Engineers



Victory Garden of Crystals

Most synthetic crystals contain water. Under sustained operation, heat drives off the water, destroys the crystal. To lick this trouble—which put vital Navy electronic apparatus out of action, new equipment using a water-free synthetic crystal was developed by Bell Telephone Laboratories.

It was the job of engineers at Western Electric to set up equipment for *growing* synthetic crystals on a mass production basis.

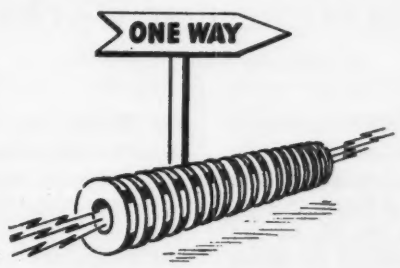
For "seeds" they use tiny pieces of crystal, "planted" in metal pans. Temperature is raised to 110° F, ammonia salt solution is added, the pans are rocked gently by mechanical means. Lowering the temperature starts crystallization. After several days, the salt solution is drained. Then the process is repeated for from 45 to 60 days.

Result: synthetic crystal bars six inches to a foot in length from which the electronic crystals—better than nature's own—are cut.

Electrical One-Way Streets

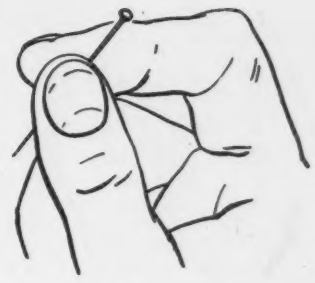
To one group of Western Electric engineers, every day is baking day. The objects of their culinary skill are copper washers and discs—from 1-16th to 1½ inches in diameter—done to a turn in a red hot oven, and with a crust of copper oxide on one side.

Piled in matched sets, these copper oxide discs are called *varistors* (variable resistors). They are high resistance in one direction, low resistance in the other, and so, in effect, allow electrical current only a one-way passage.



As radio moved into very high frequencies, specifications for precision, stability and smaller size of these rectifiers went far beyond anything previously attempted outside the laboratory.

Western Electric's manufacturing engineers set up shop for quantity production of these interesting little devices. The techniques they have developed have great significance for post-war communications.



Smaller than a Pinhead

Thermistor—thermal resistor—is the name of a class of solid variable resistors used as circuit control elements. These tiny units must be sturdy and dependable, yet extremely sensitive in response to temperature variations.

Most thermistors begin life as a metallic oxide paste. This is processed; "fired" under carefully controlled atmosphere and temperature conditions; then formed into beads on fine wires, pressed into discs or extruded as rods.

One interesting manufacturing problem arises from their size, which may be smaller than a pinhead. To manufacture these tiny devices, some of the operations must be performed under microscopes.

Developing and setting up techniques for quantity production of these precise units is another accomplishment of Western Electric engineers.

Manufacturing telephone and radio apparatus for the Bell System is Western Electric's primary job. It calls for engineers of many kinds—radio, electrical, mechanical, chemical, metallurgical. Many of the things they do—whether seemingly little or big—contribute greatly to the art of manufacture of communications equipment.

Western Electric

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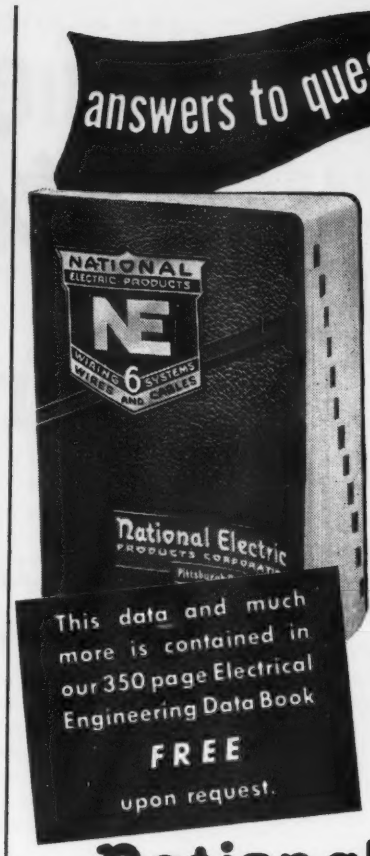

- Housing wires and cables in walls and floors.
- Surface housing of wires on ceilings, walls and floors with greatest efficiency and neatness.
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- Wires and cables to suit every industrial, commercial and domestic power requirement.

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HIGH TEMPERATURE HOT WATER HEATING

(*Continued from page 345*)

flow measurements to avoid the use of small fractions. As shown on Figure 5, approximately 2.5 ft. of static head (or 30 in.) exerts a pressure of 1 lb./sq. in. at the bottom of the water column. Therefore a head of 1 ft. (or 12 in.) exerts a pressure of 0.400 lbs./sq. in. at the bottom of the column. This may be defined as equal to 12,000 milinches of friction head. These conversions may be used when required.

To determine the total head against which the pump must operate, it is necessary to know the total length of piping in all circuits, and the various relative positions of the equipment in the various circuits. These data may be read from an accurately drawn sketch of the piping system. It is also important to have the various circuits balanced for equal friction flow, and this may be accomplished by the use of a reversed return. Figure 2 shows diagrammatically a typical piping hook-up with suggested locations for the various pieces of equipment.

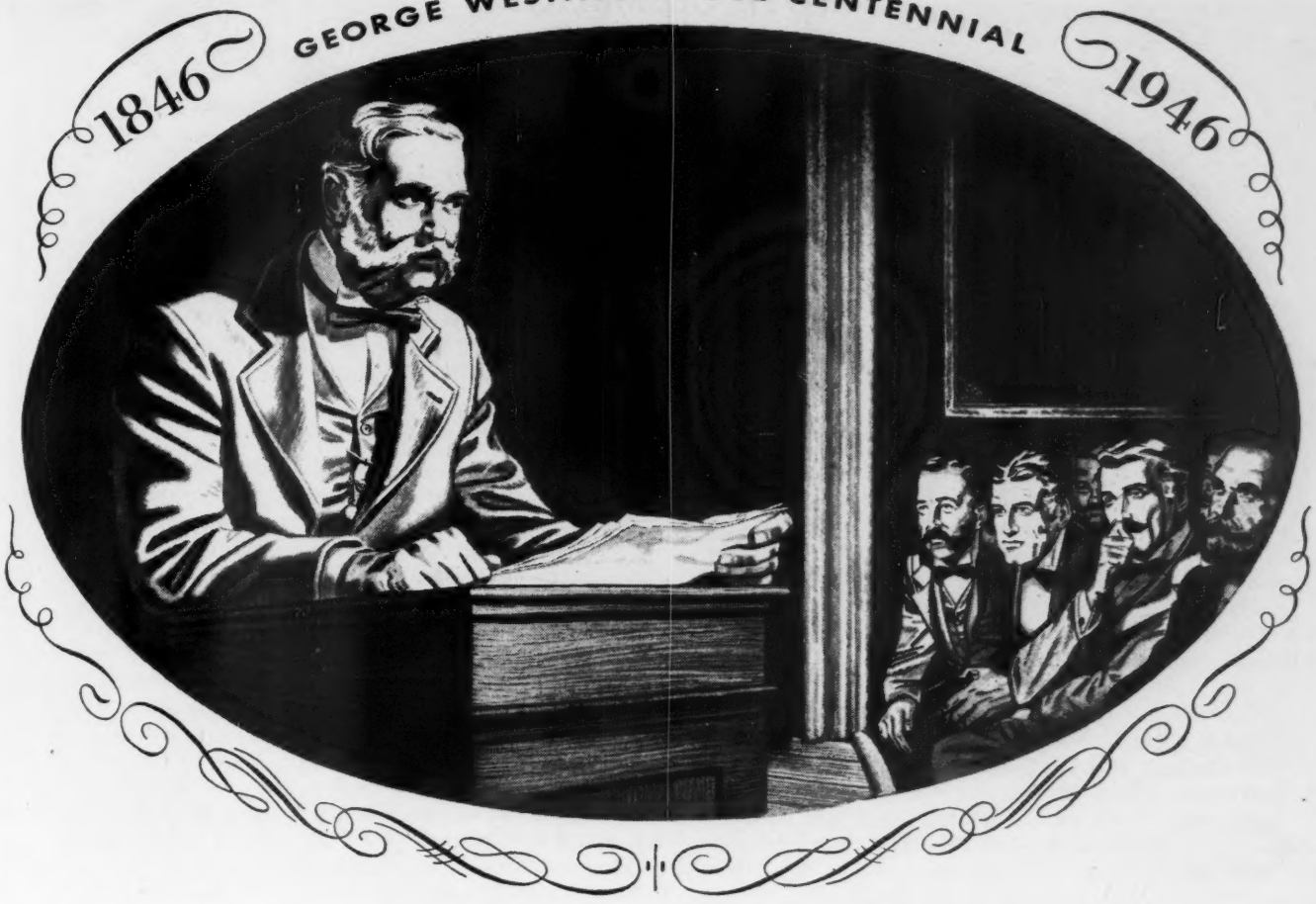
After careful considerations as to the largest allowable pipe size, the maximum allowable head against which the circulating pump should operate, and the greatest permissible velocity of the water flowing through the piping, the total pressure head of the circulating pump may be calculated. By establishing a tentative basic milinch friction drop value per foot of pipe, the piping may be sized. The total milinch friction loss in the longest circuit plus the friction through the equipment in that circuit will give the total head against which the circulating pump must operate. That is, of course, should this circuit be the one offering the greatest resistance to flow in the entire system, and invariably it will. Otherwise the circuit with the greatest resistance must be used in the calculations.

A pump may now be selected from manufacturer's tables, so chosen to pump a specific volume of water against a given head.

Auxiliary equipment such as check valves, balancing valves, and operating and controlling devices should be installed where required. It is the auxiliary equipment installed in such a system which makes the "300 design" possible. In addition, a blow-off tank should be placed in the piping system, located adjacent to the boiler in the event it is necessary to "dump" the water in an emergency. A quick opening valve placed in the blow-off line between the boiler and the blow-off tank will serve for this purpose. (See Figure 2.)

* * * * *

In summary: the "300° system" represents a most practical solution to an efficient high temperature hot water heating system. Although this article has primarily dealt with continuous flow heat transfer processes, the "300° system" may be very satisfactorily used for batch heating (distillation), and steam or vapor generation.



Prophet, *with* honor . . .

"Had a Jules Verne sought to imagine some universal servant of mankind, he would well have depicted some *magic agent* which would apply Nature's forces to do man's work . . . which could take the energy out of hidden coal and falling water, carry it by easy channels and cause it to give the light of a million candles, the power of a thousand men — or to produce heat without combustion, and unlock chemical bonds and release new materials . . ."

These are words of George Westinghouse, prophetic words because he uttered them many years ago on the subject of *electricity*—and then, as inventor and forward-looking industrial leader, did much to make them come true.

Scientific societies, kings, and governments throughout the world honored George Westinghouse with their proudest medals and decorations.

But he himself built his own lasting monument to greatness — the giant industries he created. They serve today because they were founded by a man who looked ahead into the *future of human needs,* then found the practical means to satisfy them.

George Westinghouse Centennial Forum

As a fitting tribute to the memory of George Westinghouse, a meeting of distinguished scientists and engineers will be held in Pittsburgh, from May 16th to May 18th.

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FINITE GEOMETRY

(*Continued from page 352*)

4. One point, F, remains.

5. Medians AU, OW, LX go through but four points. Since all lines must contain five points, AU, OW, and LX must all pass through the lone remaining point F.

4. There are twenty-five points in all. Triangles AWK, LOU, and KSR include but twenty-four.

5. (Refer to *Theorem 3.*) The medians cannot have for their fifth point any of those points on triangles AWK, LOU, and KSR for this would also violate the axiom, "Two points determine a line." (For instance, suppose AU decided to have, say, G, and not F, for its fifth point. Then the points U and G would be on both AU and OU, an impossibility.)

Now that we have established the concurrency of the medians for a twenty-five-point geometry, we begin to get swelled heads. We think that we have "confirmed" the analogous Euclidean theorem. We feel that any old finite geometry will yield the same result.

Let us take a general system with n points on a line and d dimensions. *Assuming the same method of proof as the foregoing,* we have the condition that after all the distinct points on a number of triangles have been accounted for, there will be one point remaining. Thus the number of points under consideration is n^d-1. The "outer" triangle will contain $3n-3$ points (see step 1 of *Theorem 4*). The next triangle will have $n-2$ points on each line (each side cutting the outer triangle twice), or $3n-3(2)$ points in all. The third triangle will have $n-4$ points on each line (each side cutting each of the outer two triangles twice), or $3n-3(4)$ points in all. Continuing in this manner until $(k+1)$ triangles (including all points but one) have been tabulated, we get:

$$(3n-3)+3n-3(2)+3n-3(4)+\ldots+3n-3(2k)=n^d-1$$

Grouping the $(3n)$'s together and expressing the other integers in terms of an arithmetic series yields:

$$3n(k+1)-3-3\left(\frac{k}{2}\right)(2+2k)=n^d-1.$$

Whence:

$$3nk+3n-3-3k-3k^2=n^d-1.$$

Solving for k gives:

$$k=\frac{3n-3}{6}\pm\frac{1}{6}\sqrt{9n^2+18n-15-12n^d}=\frac{1}{2}(n-1)\pm\frac{1}{2}\sqrt{n^2+2n-\frac{5}{3}-\frac{4}{3}n^d}$$

Whence:

$$(2k-n+1)^2=n^2+2n-\frac{5}{3}-\frac{4}{3}n^d.$$

We know that n, k, and d must all be integers. We also know that the condition $n=ad+1$ must be satisfied. We now notice that all values of n greater than 6 will start making the right-hand side negative if d is 2. For d greater than 2 all values of n make the right-hand member negative. If $n=2$ or 4 when $d=2$, the condition $n=ad+1$ is violated, and $n=3$ causes the right-hand member to be fractional. The only remaining possibility that will satisfy the equation is $n=5$, $d=2$, $k=2$ (which checks *Theorem 4*).

Of course, for, say, $d=3$, $n=4$, some of the fundamental theorems do not hold (e.g., on a four-point line, some pairs of points will have two mid-points, others none). The general solution is not valid for $d>2$. However, in a two-dimensional system, there seems to be little doubt that $n=5$ makes for the only solution in which the medians of a triangle are concurrent. What mystical properties has the number five to enable it to reproduce theorems of Euclidean geometry in finite geometry, when no other number will do the trick?

Speaking of mystical properties, I shall conclude with a word about higher-dimensional finite geometries. All appeals to intuition in this domain are totally inept, for a nineteen-dimensional world, for instance, is hopelessly beyond the visualization of any mortal being. Furthermore, even simple concepts are gruesomely complicated. Take the case of two "skew" lines in our nineteen-dimensional world, for instance. They might lie in different planes in the same solid; or lie in different solids in the same hypersolid, etc. In other words, there would be different degrees of skewness, depending upon the lowest-dimensional world common to the two lines in question.

In spite of these catastrophic difficulties, however, I have been able to derive a formula for the total number of s-dimensional figures existing in a finite geometry of d dimensions and n points per line. This formula is of great interest, and seems on the face of it virtually impossible to obtain. Follow closely:

In each matrix, the number of s-dimensional figures will be the total number of points times the number of s-dimensional figures passable through a point divided by the number of duplications that this s-dimensional figure will perform in passing through all of its points.

The number of points in an s-dimensional figure is n^s. The total number of points is n^d. The number of matrices may be found by choosing one point and dividing one less than the total number of points by the number of points in line with the chosen point in each matrix. Thus, the number of matrices is $\frac{n^d-1}{d(n-1)}$. (In order for this fraction to come out a whole number, n must equal $ad+1$, as stated previously.) The number of s-dimensional figures passable through a point is evidently the number of combinations of s things out of d, C_s^d.

Putting all these quantities together, we find that the total number of s-dimensional figures is:

$$\frac{(n^d)(n^{d-1})(C_s^d)}{(d)(n-1)(n^s)}.$$

Planning a nightmare? Don't let pure mathematics enter into it. The foregoing is not too difficult; once you get the hang of it, it stimulates the imagination, and it's fun.

I'm convinced.

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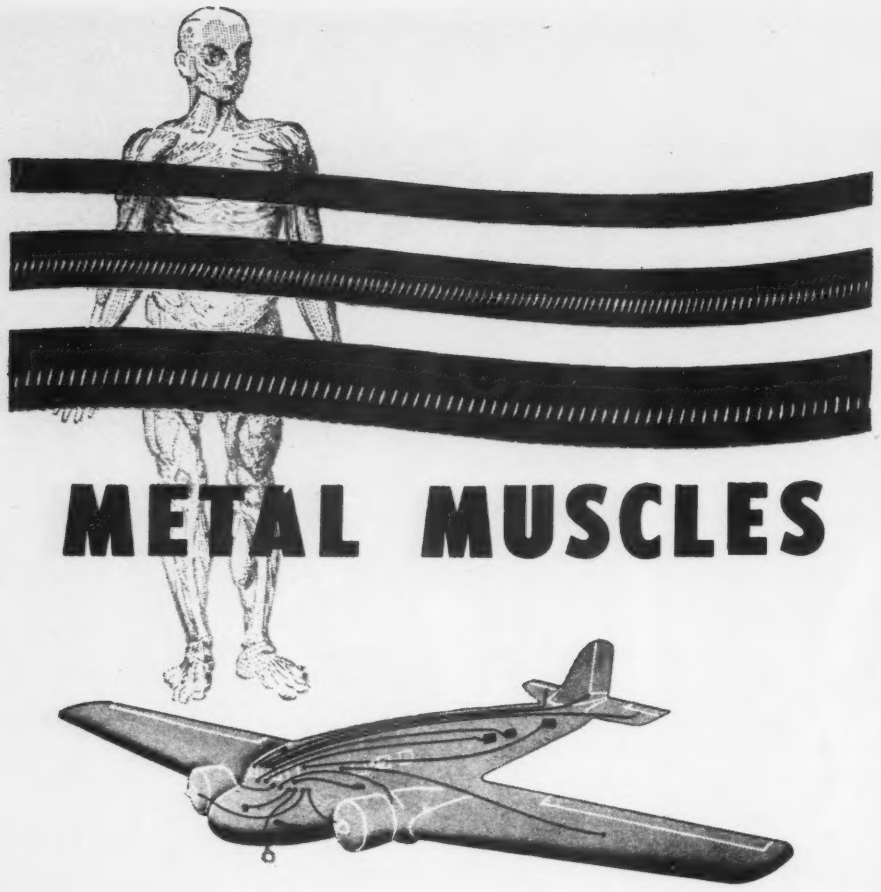

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FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

DYESTUFFS IN ACTION!

(*Continued from page 341*)

dyes is that they are physiologically safe. To determine this factor and to assure minimum standards, the Federal Security Agency, Food and Drug Administration, maintains testing laboratories. The "certified" dyes and toners are synthetic, organic products. At least eighty-five synthetic coloring agents are tolerated by practically every person, but to others many people are decidedly allergic. This means that many tests must be made on human subjects, and a statistical relationship worked out for each and every dye.

Many of the dyes, although approved, change slightly under body conditions. For instance, D. & C. Red No. 21, a yellowish-red dye, is converted into a bluish-pink dye by the alkali of the blood. Rhodamine B, a powerful red dye, tends to penetrate into the body of the nail when used on nail polish. Thus little Mary, trying on her mother's nail polish, might be caught with the goods if the polish happens to contain Rhodamine B.

Merchandisers in the food color field must do much research to determine the effect that various colors have on the customers. For some reason, blue and black are not very appetizing colors — blue colored butter would remain for a long, long time on the shelves of the retailer except during wartime shortages. Many other surprising colors are found in food, but the best example of all is the yellow dye that colors foodstuffs like butter — otherwise known as the monosodium salt of 1-(4-chloro-o-sulfophenyl)-5-hydroxy-3-methyl-4(p-(p-tolylsulfonoxy)-phenylazo)-pyrazole. Imagine taking all that in one gulp!

COMING AGAIN IN OCTOBER!

T. E. N.

—bigger

—better

WATCH FOR IT

The picture that sold a lot of dresses . . .

THIS isn't a fashion picture today, nor was it in 1896 when it appeared in newspapers all over the world. But this picture prompted a London department store to take advantage of the occasion by advertising and selling "x-ray proof dresses."

It was also reported that x-rays would be used by medical colleges to implant anatomic diagrams directly into the brains of future doctors. And some people suggested the whole business be forgotten before the new rays brought about the total destruction of mankind.

Such was the popular reception accorded Roentgen's discovery of the x-ray 50 years ago. Few people, even scientists, could foresee that within a half century this discovery would become a major weapon against disease, and an industrial tool that would help win World War II.

Corning first appeared in the "x-ray picture" some 30 years ago, when the development of this science seemed to be reaching its limit unless tubes could be produced of a glass capable of high transmission of x-rays and capable of withstanding extreme heat and high voltages for long periods of service. Here is where Corning skill was instrumental in furnishing bulbs to x-ray tube manufacturers, just as it has furnished glass with special properties for countless other fields . . . all the way from elaborate laboratory apparatus to glass cooking utensils, from giant airway beacon lenses to an all-glass pump for handling corrosive acids. Corning, with its years of experience, is anxious to help you learn all about glass today. For tomorrow, that knowledge will come in handy on your new job. Why not write us? Corning Glass Works, Corning, N. Y.

CORNING
means
Research in Glass

Massachusetts Institute of Technology
CAMBRIDGE, MASSACHUSETTS

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY
offers the following Professional Courses:

SCHOOL OF ARCHITECTURE

Architecture — City Planning — City Planning Practice

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Chemistry
Food Technology
Food Technology — Five Year Course
General Science
Geology
Mathematics
  Options: Pure and Applied Mathematics
  Industrial Statistics
Physical Biology
Physics
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SCHOOL OF ENGINEERING

Aeronautical Engineering
Building Engineering and Construction
  Options: Heavy Construction
  Light Construction
Business and Engineering Administration
  Courses: Based on Physical Sciences
  Based on Chemical Sciences
Chemical Engineering
Chemical Engineering Practice
Civil Engineering
Electrical Engineering
  Options: Electric Power
  Illumination Engineering
  Electrical Communications
  Electronic Applications
Electrical Engineering — Co-operative Course
General Engineering
Marine Transportation
Mechanical Engineering
  Options: General Mechanical Engineering
  Engineering Science
  Automotive Engineering
Mechanical Engineering — Co-operative Course
Metallurgy
  Options: Metallurgy
  Mineral Dressing
Meteorology
Naval Architecture and Marine Engineering

The duration of each of the above undergraduate Courses is four academic years, with the exception of Architecture, Food Technology (Five Year Course), Physical Biology, and the co-operative Courses in Electrical Engineering and in Mechanical Engineering, which extend over a period of five years, and City Planning Practice which covers a period of six years. In addition to the Bachelor's degree, the above five and six year Courses, with the exception of Architecture, lead also to the Master's degree.

Graduate study, leading to the Master's and Doctor's degrees, is offered in Ceramics and in most of the above professional Courses.

A five year Course is offered which combines study in Engineering or Science, and Economics. This leads to the degree of Bachelor of Science in the professional field, and to the degree of Master of Science in Economics and Engineering or Economics and Natural Science.

For information about admission, communicate with the Director of Admissions.

The Catalogue for the academic year will be sent free on request.

"Hold on thar stranger...!"

Millions of American youngsters enjoy the delicious thrill of adventure every day with their favorite heroes of the airwaves.

And every one of them would be bitterly disappointed if anything were to interrupt the flow of electric power which makes these exciting radio dramas possible.

A minor tragedy? Of course. But an indication, nevertheless, of how much we have come to depend upon a constant, uninterrupted flow of electricity for our pleasures, our work, our health, our daily living.

Bartlett-Hayward Division of Koppers manufactures a unit which helps to assure that steady, uninterrupted flow of electric power. It's called Fast's Self-Aligning Coupling. This coupling is used to join engines to generators, generators to motors, motors to blowers and pumps and other rotating power equipment. And the coupling adjusts itself automatically to misalignments of the connected machines, so that the motors keep running smoothly and the power keeps flowing.

This coupling has done its share to make Koppers "the industry that serves all industry". Just as the designing and building of coke ovens, the production of chemicals from coal, the treating of timber, the making of roofing, paving, piston rings and many other products have played their part in helping Koppers to serve American industry and, in turn, the American public. Koppers Company, Inc., Pittsburgh 19, Pa.

The industry that serves all industry

KOPPERS

EVEN JUNIOR CAN'T DENT IT—IT'S MADE OF ROEBLING STRIP STEEL!
BETTER TELL SALLY TO GIVE UP TOO— THAT'S ROEBLING ELECTRICAL WIRE
JACK MARKOW

Roebling produces every major type of wire and wire product . . . house wire to telephone cable . . . bridge cable to wire rope . . . fine filter cloth to heavy grading screen . . . strip steel and flat wire to round and shaped wire . . . all Roebling products. *All* the result of over 100 years of wire specialization.
John A. Roebling's Sons Company, Trenton 2, N.J.

JR ROEBLING

ROEBLING

PACEMAKER IN WIRE PRODUCTS

WIRE ROPE AND STRAND • FITTINGS • SLINGS • SUSPENSION BRIDGES AND CABLES COLD ROLLED STRIP • HIGH AND LOW CARBON ACID AND BASIC OPEN HEARTH STEELS AIRCORD, SWAGED TERMINALS AND ASSEMBLIES • AERIAL WIRE ROPE SYSTEMS • ROUND AND SHAPED WIRE • ELECTRICAL WIRES AND CABLES • WIRE CLOTH AND NETTING

ION EXCHANGE RESINS

(*Continued from page 354*)

is not objectionable, it is excellent. The salts that are replaced by equivalent amounts of the corresponding acids.

(*c*) Use of a combination unit of cation and anion exchanger. This method will remove all the ions present. The advantages are obvious.

When considering the volume of product treated, the field of carbohydrate purification, as exemplified by cane and beet sugars, corn sugars, starches, etc., is of particular interest. Removal of the salts present in the juice of sugar cane or sugar beets is desirable for several reasons:

(*a*) The calcium salts present, occurring naturally or introduced during purification process, cause excessive scaling during boiling and evaporation of the juice, resulting in decreased efficiency of the evaporators and higher operating costs due to poor heat transfer and accompanying power loss.

(*b*) The salts present in the sugar during the evaporating and crystallizing stages are said to be "molassogenic," that is, they retard crystallization of the sucrose and increase the yield of molasses per ton of juice treated. Therefore any method of decreasing salt content economically is of very definite interest, and the ion exchange materials have been proved by test. Their application to this process is too recent a development to be completely evaluated at present, but its future possibilities are excellent.

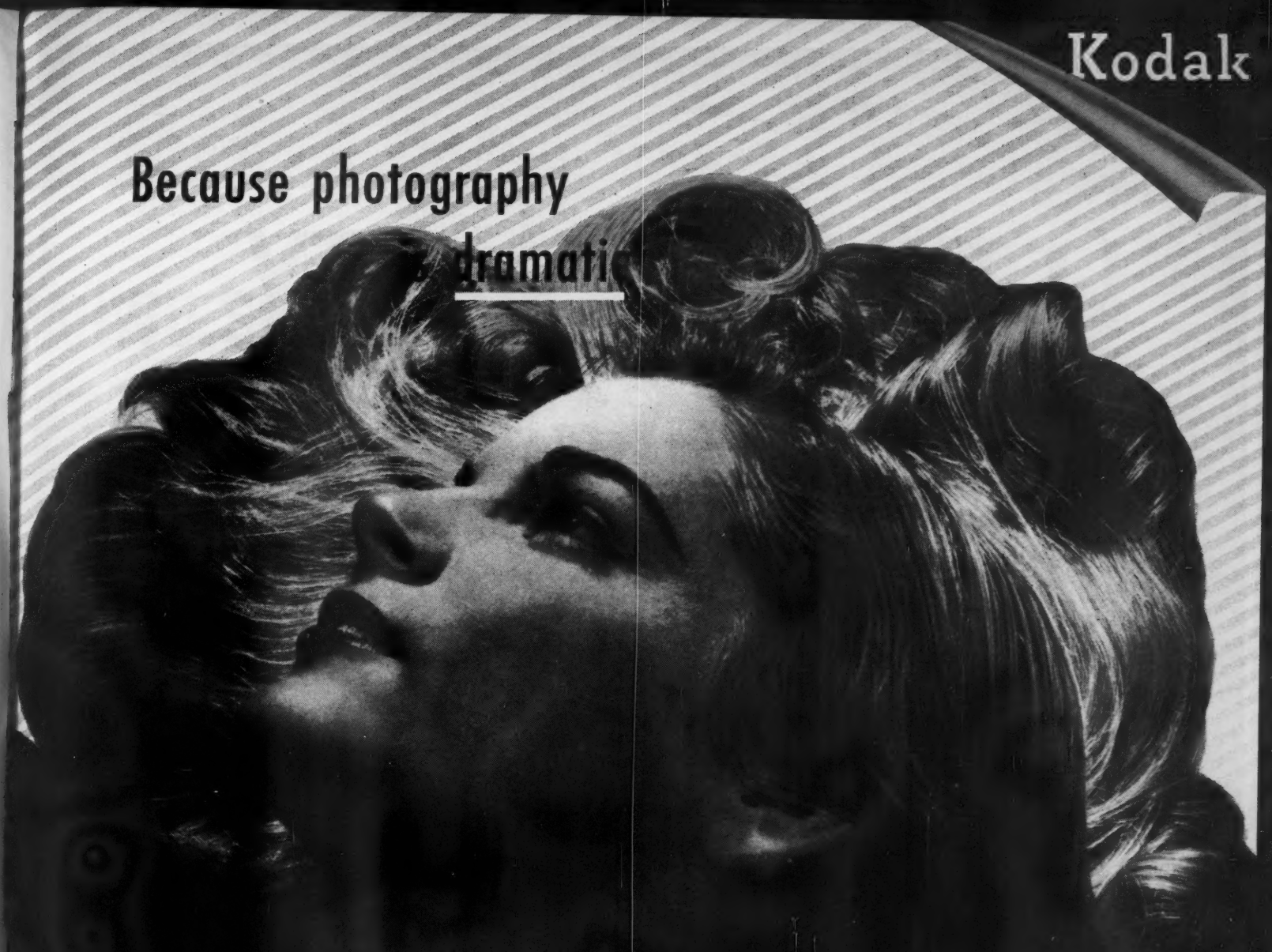
8. Purification of organic bases: Since many organic bases hydrate to a certain degree, and therefore act as substituted ammonium salts, it can be seen that these materials could be substituted for either sodium or hydrogen in the resin, and then regenerated in pure form with little difficulty.

Similarly, the concentration and recovery of such compounds from dilute solution are indicated.

9. Acidification and deacidification: This process has little important technical value. The only important use is the removal of formic acid from solutions of formaldehyde, which usually contain this acid as an impurity due to air oxidation.

10. Purification of gases and removal of valuable constituents therefrom: This is one of the most interesting new developments in this field. It has been found that the

(*Continued on page 380*)



YOU KNOW what can be done with photography to dramatize beauty. But do you know what can be done with it to dramatize ideas . . . products . . . processes . . . technics?

With eye-arresting photographic illustrations in your advertising . . . with motion pictures . . . you can add color, spark, interest to the presentation of any idea or product. Get quicker and greater acceptance through your showmanship!

With movies and slide films, you can dramatically explain the whys and wherefores of basic processes and technics . . . make training programs more understandable, more interesting, and, therefore, more productive.

Beyond these, there are many other uses to which business and industry can put photography. For a brief description of some of these uses, write for our new, free booklet—"Functional Photography."

EASTMAN KODAK COMPANY
Rochester 4, New York

Functional Photography

Advancing business and industrial technics

LET'S X-RAY A CITY...WHA

You see . . . people flipping switches to light their homes and offices.

You see them setting dials to control air temperatures.

You see them turning faucets to get fresh, pure water.

You see . . . a fabulous, hidden world of machinery—power plants, heating systems, pumping stations—producing the magic that makes great cities possible . . .

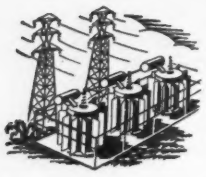
You see . . . Allis-Chalmers engineering aiding all industry to further good living for everyone!

* * *

There is hardly a manufactured thing employed or enjoyed in modern good living—to which Allis-Chalmers engineering "know-how" does not contribut

The steel and concrete that for the city's skeleton . . . the electri power that brings it to life . . . the wat supply and sewerage facilities . . . th turning wheels of its industries . . . th very bread on its breakfast tables—a these and more, Allis-Chalmers m chinery helps bring to *your* good livin

But it is not bigness alone tha



For the producer, distributor, or user of commercial electric power, Allis-Chalmers provides new and improved power generating units, transformers, unit substations, switchgear, control, circuit-breakers, switchboards, rectifiers, converters, regulators, motors, and scores of other electrical products. In electrical equipment, Allis-Chalmers is a good name to know.

ALLIS-CH

← One of the Big 3 in Electri

Biggest of all in Ra

HA DO YOU SEE?

contribut as made Allis-Chalmers one of the that for orld's greatest industrial names. It is ne electr e soundness of Allis-Chalmers engi- the wat eering—the integrity of workmanship ies . . . t hat makes every product stamped es . . . t A-C" great.

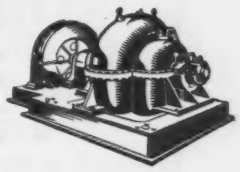
ables—a Allis-Chalmers is a good name to mers m now!

ood livin *llis-Chalmers Manufacturing Company*
alone tha *Milwaukee 1, Wisconsin*

TUNE IN THE BOSTON SYMPHONY over the American Broadcasting Company, Saturdays, 9:30 P. M. EST

HALMERS

tri Power Equipment—
Range of Industrial Products



Pumps to handle a city's water are among the 1600 products of Allis-Chalmers engineering. To every basic industry—food, iron and steel, mining, petroleum, paper, wood, metal working, chemical, construction, transportation, textile—Allis-Chalmers supplies essential machinery. Whatever your equipment need, call the Allis-Chalmers office in your city.

DOUBLE FLUORIDES OF ZIRCONIUM

(*Continued from page 349*)

as high a purity of K_2ZrF_6 as the regular process. This offers opportunity for reducing the commercial price if the purity factor is not an essential one in the fields which use K_2ZrF_6.

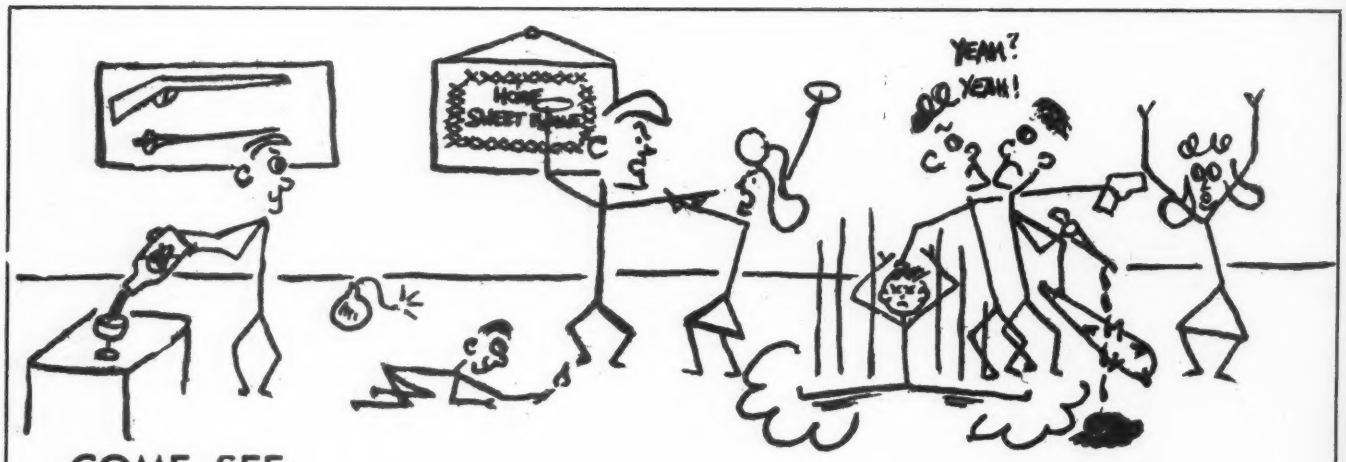
One of the uses of the double fluoride is in the production of pure zirconium dioxide through the hydroxide. If alkali is added to a solution of potassium zirconium fluoride, a white precipitate, varying in formula with the amount of OH^- added, is obtained. If the theoretical amount of alkali (four moles of OH^- ion per mole of double fluoride) is added, the reaction is:

$$K_2ZrF_6 + 3KOH \rightarrow 6KF + Zr(OH)_4$$

To calculate the amount of alkali necessary, a graph of pH against amount of KOH may be used. The hydroxide can be filtered out, washed, and calcined. If the calcining temperature is in the region of 1000° C., the ZrO_2 formed is a light fluffy powder; however, if a temperature of 1800° C. is used, a heavy dense powder is produced. The latter is called "shrunk ZrO_2." The zirconium oxide is of a purity near 99 per cent and is used to a slight extent in the photographic industry and in the manufacture of zirconium hydride. Lower grade zirconium oxide is used in refractories. The oxide from the double fluoride is, of course, too expensive for uses that can safely and economically take the lower grades of ZrO_2 prepared by rough purification of ores.

The most important use of potassium zirconium fluoride is to prepare alloys. Zirconium adds several desirable qualities to aluminum, but the usual method of adding zirconium metal was too expensive for commercial use. This difficulty was circumvented by using a mixture of magnesium turnings and the double fluoride as the alloying agent. The alloy which results is a zirconium-aluminum one containing magnesium, and is used for airplane engine parts. The production of this alloy accounts for almost the total production of potassium zirconium fluoride at present. If titanium is also added to the alloy, the properties of the resulting material are considerably improved in certain respects. Experimental work is now being done in an effort to obtain K_2TiF_6 and to use it in the same way as the corresponding zirconium compound.

It was found that a small amount of K_2ZrF_6 added to molten copper alloy acts as a scavenger and gives rise to a very desirable crystal formation. The zirconium tetrafluoride is used to prepare zirconium metal which is used as a "getter" in radio tubes. Zirconium metal is also produced by fusing the double fluoride and electrolyzing the melt with control of the voltage within very narrow limits. K_2ZrF_6 can be used as a filter-aid for K_2TiF_6, especially when they are going to be charged into the same batch of aluminum for preparation of a Zr-Ti-Al alloy. Potassium zirconium fluoride has been in commercial production only since early 1945. Its uses as yet have not been fully investigated and there is a promising new field for scientists in applying this salt to industry.



COME SEE:

"The Little Foxes"

IT WILL REMIND YOU OF HOME—

Presented by the M. I. T. Dramashop

MAY 24 and 25
8.30 P. M.

PEABODY PLAYHOUSE
$1.20

Du Pont Digest

Items of Interest in the Fields of Chemistry, Engineering, Physics, and Biology

America Learns to Make Its Own Camphor

FOR YEARS, the Japanese maintained a tight hold on the world's camphor supply.

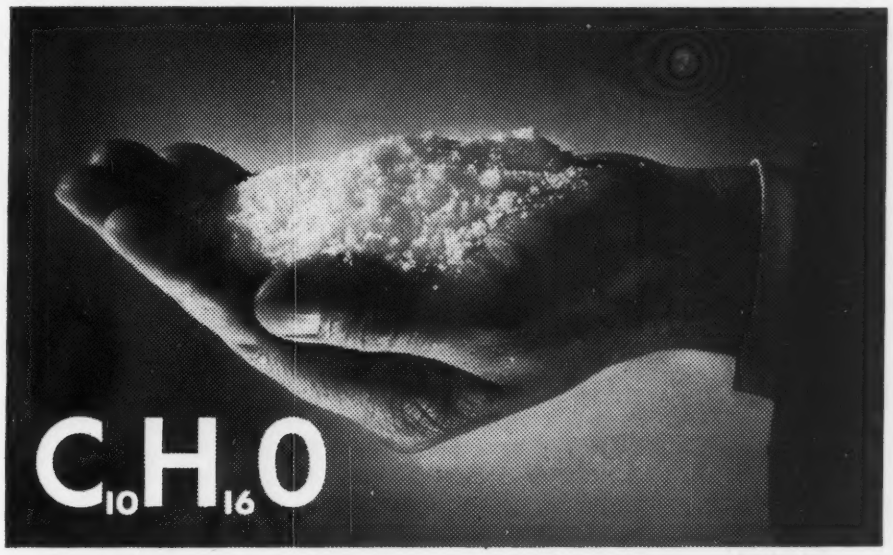
Americans had to have camphor in ever-increasing quantity for the manufacture of photographic film, celluloid, plastics, perfumes, medicines, lacquers and disinfectants. But they were forced to pay whatever price the Japanese chose to ask. And even at 1919's exorbitant top figure of $3.75 a pound, they were never sure of a full supply.

Men of Du Pont undertook to make this country independent of such an unsatisfactory source. They knew that camphor could be synthesized, but to make it at low cost and in large quantities was an entirely different matter. Long years of experiment and research produced little but disappointment. But finally, in 1932, a way was found to produce low-cost chemical camphor on a commercial scale that matched nature's product in color, texture, scent and usefulness.

$C_{10}H_{16}O$ from Turpentine

Basic material from which Du Pont camphor is made is pinene, obtained from turpentine from southern pine trees. The formula of pinene ($C_{10}H_{16}$) seems to differ but little from that of camphor ($C_{10}H_{16}O$), but the structural difference is considerably greater than is indicated by the single atom of oxygen. Although the chemical conversion of pinene to camphor is not difficult to accomplish in the laboratory, to do so economically on a commercial scale taxed the ingenuity of many Du Pont chemists, engineers and designers.

World War II completely shut off the supply of natural camphor. But within a few months Du Pont production men were able to step up the output of the man-made product to take care of military, medical and civilian needs. Today this supply is going into the manufacture of hundreds of products that will bring



more comfort, more satisfaction, more joy into the lives of millions.

All the men at Du Pont—chemists, mechanical engineers, civil engineers, and hundreds of others who worked on this development—feel great pride that they were able to free their country from foreign sources for such a vital material in our industrial life.

• • •

SYNTHESIS OPENS NEW ERA IN PERFUME MANUFACTURE

Some of the most interesting discoveries at Du Pont have come from "fundamental" research groups assigned to establish new scientific facts without regard to immediate commercial use.

Synthetic musk is an example. Musk is the most important single ingredient used in perfumery, a fixative blending many subtle odors into one fragrance and making it lasting Until recently its only source was the musk deer of Tibet, an animal nearing extinction.

Then Du Pont organic chemists, in their long-time study of giant molecules, noted that a group of ring compounds called macro-ketones resembled musk in odor. Following up their observations with intensive research, they produced compounds of even more pronounced likeness.

Now, in "Astrotone," perfumers are offered a synthetic musk that is of a determined strength, immediately usable and as powerful as the pure essence of natural musk.

More facts about Du Pont—Listen to "Cavalcade of America," Mondays, 8 P.M. EST, on NBC

Questions College Men ask about working with Du Pont

"WILL AN ADVANCED DEGREE HELP ME AT DU PONT?"

There are many Ph.D.'s at Du Pont. However, the majority of our chemists, chemical and mechanical engineers, physicists and biologists are Bachelors or Masters. Every effort is made to see that full recognition is made of a man's scientific training, as well as his special experiences and aptitudes. For certain openings, a higher degree is a distinct asset.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

E. I. DU PONT DE NEMOURS & CO. (INC.)
WILMINGTON 98, DELAWARE

Answers to:

Can You Do It?

Here are the answers to the problems in both last month's and this month's issues.

APRIL

Problem 1: Actually, this one is a rather dirty trick. Of course the diameter of the circle can be found by means of some fancy algebra and geometry involving Pythagoras' theorem and the theorem which says that the products of the segments of chords within the same circle are equal. It is much easier, however, to remember that the diagonals of a rectangle are equal and then to notice that the other diagonal of the given rectangle happens to be the radius of the circle. Thus, by inspection, the diameter of the circle is 18 units.

Problem 2: The third view of the given solid will be another circle, exactly the same size as the circle in the top view. Unfortunately, the resultant object is a little hard to visualize. The solid is actually the volume common to two circular cylinders of equal diameter whose axes intersect in a right angle.

MAY

Problem 1: This one's a little involved, so try to follow the reasoning carefully. For the first time through we shall assume the worst possible luck — and at the same time the greatest probability. Then we shall go back and deal with the other possibilities.

Divide the 120 pennies into three stacks of 40 each. Then weigh two of the stacks against each other. There are two possible results: the stacks will balance or they will not. The first result is the least probable, and we shall deal with it later. The second result is the most probable, for it eliminates the least number of pennies. Thus we now have two stacks, one heavy and one light. The remaining 40 pennies are eliminated because the unequal stacks obviously must contain the odd penny. Diagrammatically we now have:

40 H 40 L

where "H" signifies pennies that have weighed heavy.
"L" signifies pennies that have weighted light.

Marking the coins in one of the stacks so that we can keep track of them, we then subdivide the two stacks totalling 80 pennies into three groups. One group contains 26 of the "light" pennies, while the other two groups contain 20 "heavy" pennies and seven "light" pennies each, thus:

20 H	20 H	26 L
7 L	7 L	

We will proceed to weigh the two similar stacks against each other. If they balance, the odd penny is a light penny among the 26 "light" pennies of the third stack, and separation can be obtained by continuous subdivision into groups of three. (That is, the first subdivision would be into groups of nine, nine, and eight respectively. The nines would then be weighed against each other, and so on until the penny is separated, the same type of subdivision being carried out each time.)

If, however, the two stacks of 27 do not balance, we then have the following results (capital letters represent results of the first weighing while small letters indicate results of the second):

20	Hh	20	Hl
7	Lh	7	Ll

It should now be obvious that the odd penny is either a light penny among the seven pennies that have weighed "light" all along, or a heavy penny among the 20 that have been consistently "heavy." So we are left with:

20 Hh 7 Ll

We now subdivide the remaining 27 pennies into three groups of nine, as follows:

6 Hh	6 Hh	8 Hh
3 Ll	3 Ll	1 Ll

We then repeat the procedure of weighing the two similar stacks. If they are equal, we merely divide the remaining nine pennies into three stacks; thus:

3 Hh	3 Hh	2 Hh
		1 Ll

and weigh the similar stacks. If they do not balance, the penny is a heavy penny and the final weighing separates it from the other two possibilities, this being accomplished by weighing any two of the three "heavy" pennies against each other. If they balance, the third penny is the odd one; if not, the penny on the heavy end of the balance is the odd one.

A similar procedure is used if the two stacks of three do balance. The two heavy pennies from the remaining stack are weighed — if they do not balance, the heavier penny is the one; if they do, the remaining light penny is the one.

Returning to the case of weighing nine pennies on each pan of the scale, we have seen how to proceed if they balance. Now assume that they do not balance. Obviously, the only remaining possibilities are the three pennies that have weighed "light" all along or the six pennies that have weighed "heavy."

Subdivide these nine remaining pennies as follows:

2 Hh	2 Hh	2 Hh
1 Ll	1 Ll	1 Ll

Then weigh any two stacks against each other. We have already seen, from a similar case, how to proceed if they balance. If they do not balance, then the odd penny is either the one consistent "light" penny or one of the two "heavy" pennies that have acted "heavy" all along, and we simply weigh the two "heavy" pennies against each other.

This eliminates all possibilities except for the case where the two original stacks of 40 each balance against each other. If this happens, then weigh 27 of the remaining 40 pennies against 27 of the normal, or standard, pennies. If they are unequal, then a simple process of subdivision by three's will separate the odd penny, since the weighing against the standard will tell whether the odd penny is light or heavy. If the two stacks of 27 balance, then the remaining 13 are divided into groups of nine and four, the nine weighed against nine standard pennies, and so on all the way down. Notice that only five weighings are made, no matter which way the penny happens to act.

You see, it's all very simple!

Problem 2: This one is much easier. All you have to do to be sure and place the last penny on the table is to place all your pennies diametrically opposite from your opponent's pennies. The hole in the middle of the table prevents your opponent from placing a penny in the one position which has no correspondingly opposite position for you to use. Obviously, this problem will work for any kind of table that is symmetrical with respect to the central hole. Think it over, it works.

J. W. W.

Hoover engineers don't

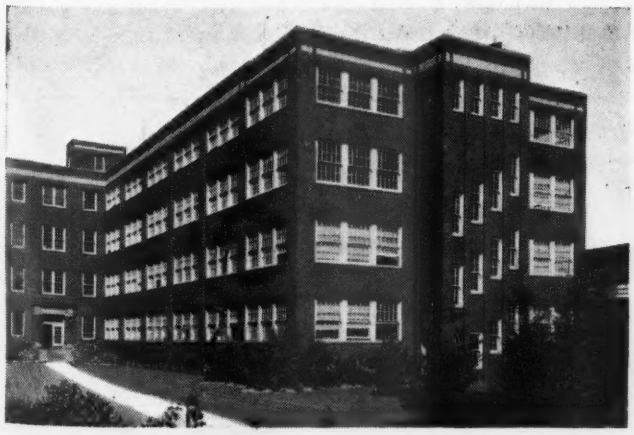
"Stick to their knitting"

The number one job for 45 graduate engineers and 85 other members of the Hoover engineering staff is to keep The Hoover Company and the Hoover Cleaner the leaders in their fields. But in doing that job as thoroughly as it is done at Hoover, they're bound to come up with developments that have important applications in other fields.

One piece of evidence: The 879 patents granted to Hoover on engineering developments include 274 that have been sought and used in other manufacturing industries—many of them far removed from the home appliance field.

This modern four-story brick building, with a total of 60,000 square feet of floor space and containing up-to-date laboratory equipment, is the Hoover Engineering Department.

The Hoover Cleaner is "born" in the development engineering division, where teamworking skilled designers, inventors and engineers plan tomorrow's electric cleaners.



The laboratory division studies and tests, rejects or recommends each component part of each new product "to be."

Mechanical engineers measure noise and vibration, design fan systems, study cleaning methods and solve power transmission problems in developing new designs.

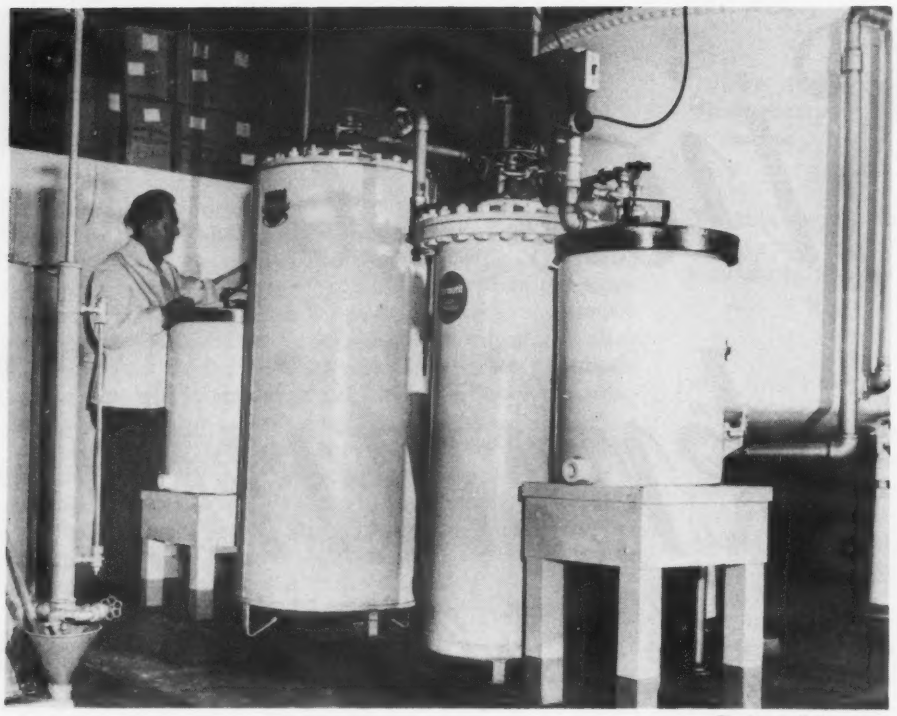
Electrical engineers develop and test motors, wiring; switches, lamps, etc., designing the right power plant and accessories for a Hoover.

Product engineers solve manufacturing problems, set up standards, see that Hoover quality is maintained.

THE HOOVER COMPANY • *North Canton, Ohio*

ION EXCHANGE RESINS

(*Continued from page 372*)



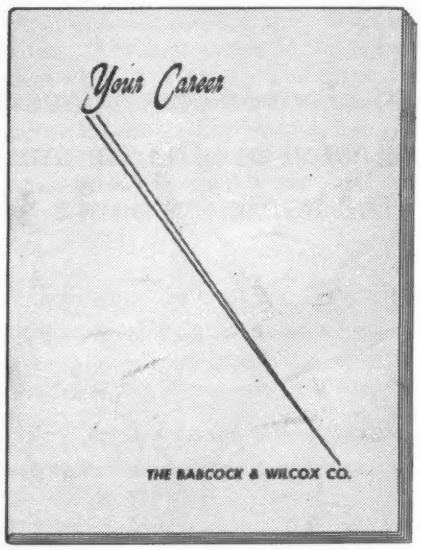
The Permutit Company

A type of exchange unit commonly used for demineralization of water.

cation exchanger will absorb ammonia, while the anion exchanger will remove gases such as sulfur dioxide and hydrogen sulfide. Although the application of these properties is only in the experimental stage, the inherent possibilities are readily apparent.

It must be realized that the previously described applications are only a few of the many varied applications for these new and unique research and industrial tools.

When one considers that these materials have been in use for only the last five years — the number of applications for these materials which have been found to date is truly surprising. Only through intensive chemical research have these methods become useful practically — and considering the amount of research being done at the present time, it would not be difficult to predict that a never-ending stream of new ideas, methods and applications will be forthcoming.



Career Opportunities for Graduates

As a career-minded technical student, you will be interested in the story of The Babcock & Wilcox Company in terms of *your* future.

Best known for the manufacture of stationary and marine boilers, B&W is also a leading producer of many other types of equipment for steam and heat utilization. Due to the continuously increasing diversification of its activities, to continuing progress in product and process development, and to the size of Company operations, B&W offers expanding opportunities in many fields such as manufacturing, engineering, research, and sales.

We shall be glad to discuss these opportunities with you in the light of your training, aptitudes, and interests. First, however, we suggest you send for the booklet, "Your Career". Address your inquiry to The Babcock & Wilcox Company, Personnel Department, 85 Liberty Street, New York 6, N. Y. G-328

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Measuring fuel performance in the Aircraft Engine Test Cell, Esso Laboratories, Bayway, N. J.

"Prove it!"

Over 2,000 research scientists and technicians are hard at work in the world's most complete petroleum laboratories – the Esso Research Laboratories! Soon the number of these research workers will be upped 20 per cent; soon close to $8,000,000 will be spent to expand those facilities.

These men and these facilities have just one job – *to develop continually finer fuels, lubricants and chemical products from petroleum.*

But their discoveries and their recommendations for improvements must be *tested* and *proved* before they can be put in effect.

That is why, for instance, a half-million-dollar aircraft engine test cell, more modern than any other in America, has been built at the Esso Research Laboratory. Here aircraft engines are run to death, *not* to test the engine – but to test the fuel. This test cell will handle everything up to 3,000 horsepower. And its equipment is the finest throughout – from its vibration-proof control room floated on cork to its 50,000 cubic feet per minute exhaust fan. Controls are electronic, tempered air for carburetion is supplied at 4 in. mercury pressure. Instead of the normal 4 or 5 checks there are 186 points for temperature determination.

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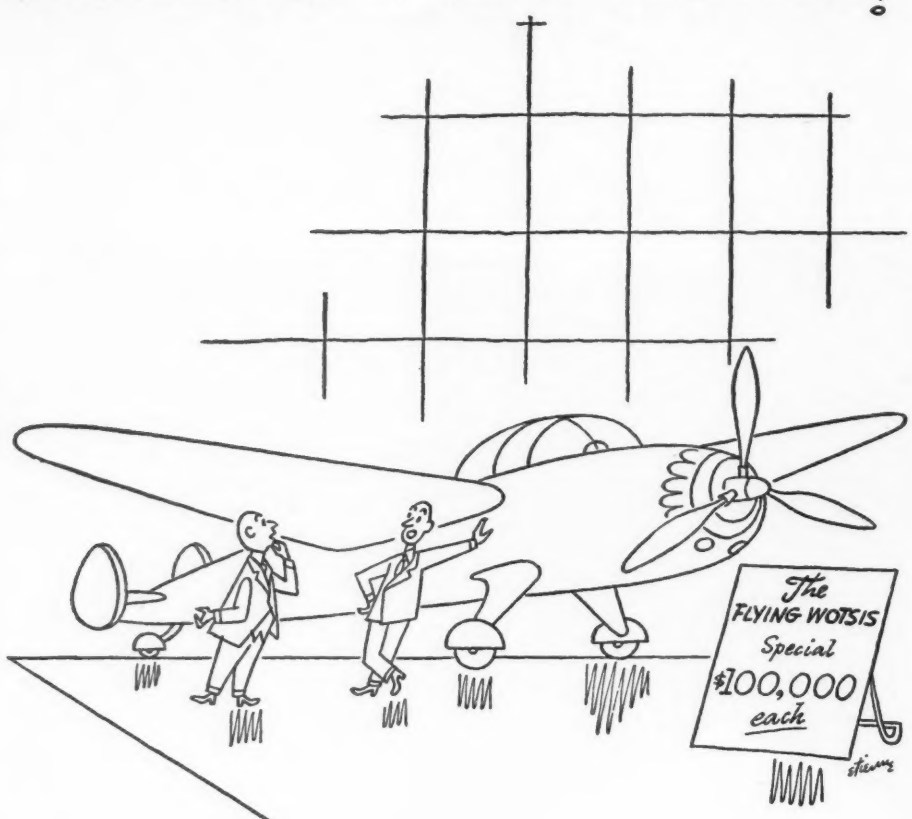

It's a fine idea, mister, but . . . by such methods the next one will cost $100,000 — and the next and the next! But do you realize that it's cheaper to make it more accurately; that there are new production methods that produce fine tolerance work at low cost?

We, at Nichols, call such methods "Mass Precision," and through 40 years of development we have proved that it is the most economical way to reduce the cost of mass production. It is not the easy way, however. It takes modern machines, engineering imagination, skilled workmen and the finest gaging equipment. Some of the results of these factors are illustrated in our new booklet "Mass Precision." It shows what we have done for others — suggests what we can do for you. A copy will be sent on your request.

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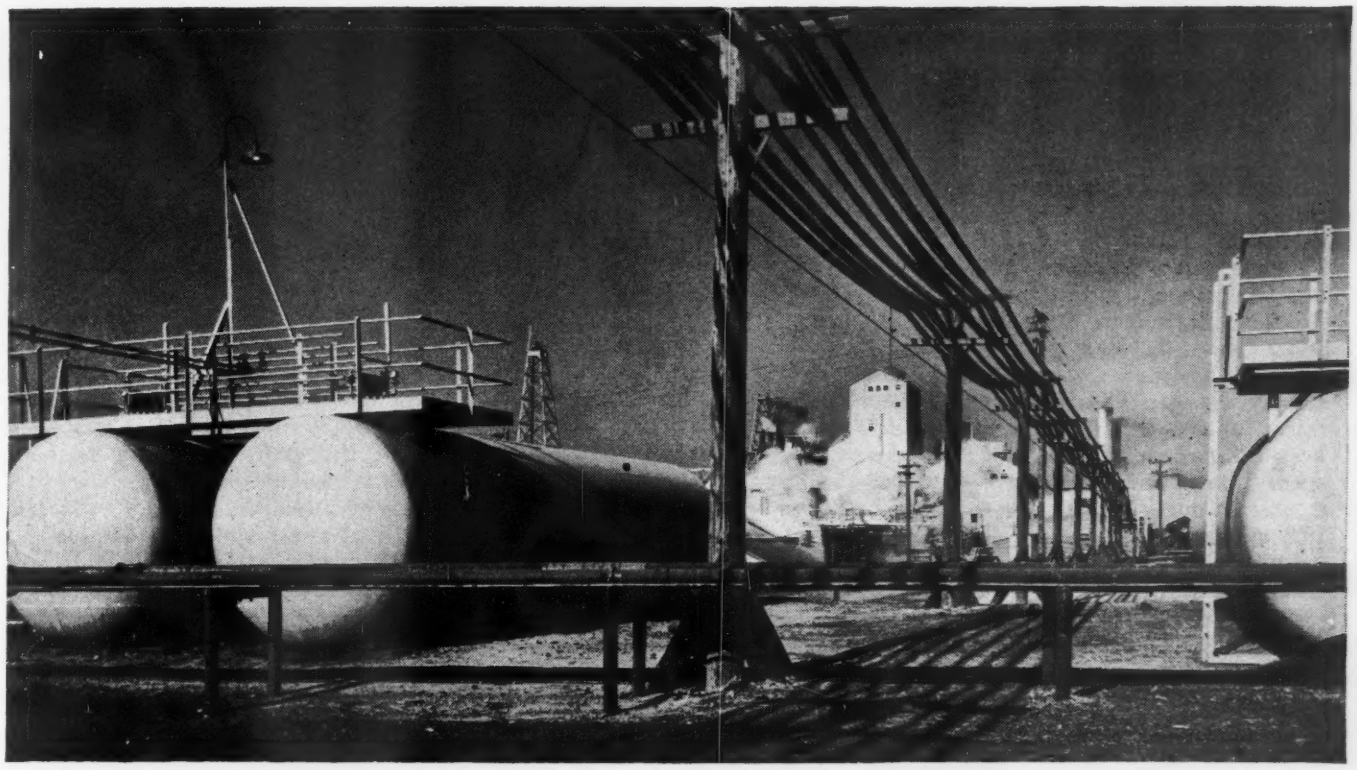
"Accurate" Nichols

PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION

Industry Relies on COLUMBIA for Essential Chemicals



Chlorine storage at Barberton, Ohio. In the background is a Columbia plant in which chlorine is produced by the electrolysis of common salt. The upper portion of a salt well derrick is in view just left of center. The heavy cables on the power line give some indication of the huge amounts of electricity consumed in the production of this important element.

SODA ASH
* CAUSTIC SODA
LIQUID CHLORINE
CALCIUM CHLORIDE
SODIUM BICARBONATE
MODIFIED SODAS

CAUSTIC ASH
PHOSFLAKE (*bottle washer*)
SODA BRIQUETTES (*iron desulphurizer*)
CALCENE T (*precipitated calcium carbonate*)
SILENE EF (*hydrated calcium silicate*)
PITTCHLOR (*calcium hypochlorite*)

Chlorine (Gr. *Choros*, Green; Cl; atomic weight: 35.46; valence: 1,3,5,7) has been variously known as dephlogisticated marine acid air (circa 1774) and oxygenized muriatic acid (circa 1785) until Sir Humphrey Davy, about 1810, showed it to be single element. Principal early uses were bleaching and disinfecting, but modern industry has found many new applications. Currently, chlorine is invaluable in the manufacture of plastics, new chemicals and solvents and for water purification.

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The Pillory

(*Continued from page 362*)

John W. Weil, '48

room from whence engineering wisdom doth emanate, the major domo was berating one of his reluctant scribes: "What do you mean, you won't write an article on ——? Why, just to show you how lazy you are, I'll —, why I'll — get the first fellow who walks in that door to do it!" The major domo waved an angry arm toward the entrance. In stepped John W. Weil.

Thus began the fabulous career of this likable beanpole who fences, practices magic, and wears his pipe upside down, not to mention raking in the kind of high cumulative that sends deans scurrying to the calculating machine to add it up and see for themselves. In his first term, John wrote articles for THE TECH ENGINEERING NEWS and generally got in everyone's hair. Because of this in his second term he was Make-Up Editor. The bane of the General Manager, he made up everything except a good reason for raising his status. In his third term he was still Make-Up Editor, but he had grown a great deal wiser for his lack of progress. As of this term it has been firmly established that John is the Editor-in-Chief of *T. E. N.*

As an active member of many other activities and the proprietor of one of the busiest rooms in the dormitories, John mystifies everyone by still managing to keep up on his work. Nevertheless, he admits that he spends much of his time dreaming of the day when classes let out for a long vacation and he can go mountain climbing again. Until that day arrives, however, John and Tech seem to be quite happily stuck with each other.

Peter E. Piccoli, '48

into the Dorm telephones' nickel slots or running up *T.E.N.*'s telephone bill after hours, buzzing her number.

Pete's ability as a draftsman has been getting around, too, in fact there's a story told about a senior who had some of his work outside rejected and he came to Pete to have them all done over. Pete made no mint out of the thing, but it is also rumored that a good part of the senior's wage was used in getting Peter to do the drawings right. No beginner, Pete's outfit would make the Graphics Department envious, complete with gadgets of all sorts, down to a lettering device with which he could forge a printer's work. We have learned that *Voo Doo* bigwigs have ofttimes sought his talent as an artist, but he remains staunchly true to *T. E. N.* (rrrhumph).

No biography of P. E. P. could possibly be considered complete without mention of his life's purpose. He earnestly hopes to be the first biped (with ears) to follow that radar signal to the moon. A real authority, he has already read practically all the literature on the subject and eagerly devours all the latest publications on the American Rocket Society. The reason for the mention of his ears is based on the uncanny fact that he holds the power to wiggle them in unison as well as individually, which we, the unbelievers, suspect is his intended secret means of propulsion.

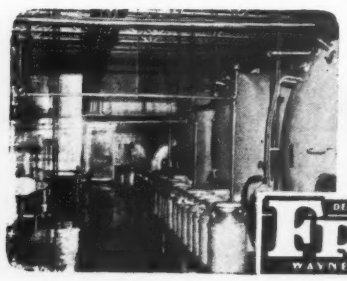
Whether or not he ever realizes his life's ambition, P. E. P. is making a real contribution to life here at Tech and we take pride in presenting him as *T. E. N.*'s Pilloried Character of the month.

George Coble Increases Dairy Business from 11 to 36,000 Daily Gallons in 11½ Years — Uses 46 Frick Refrigerating Machines, Totaling Over 2,000 Horsepower

That summarizes the remarkable growth of Coble Dairy Products, Inc., of Lexington, N. C., which now has 15 branch plants.

Starting with one small Frick compressor in 1934, Mr. Coble now uses Frick Refrigeration in all his dairies—will own 51 Frick machines when those on order are shipped. Installation by Piedmont Engineering Corp., Frick Distributors at Charlotte, North Carolina.

Another proof of the saying that "The users of Frick Refrigerating, Ice-making and Air Conditioning Equipment make money."



The Frick Graduate Training Course in Refrigeration and Air Conditioning has been operated a quarter of a century — is still going strong.

DEPENDABLE REFRIGERATION SINCE 1882

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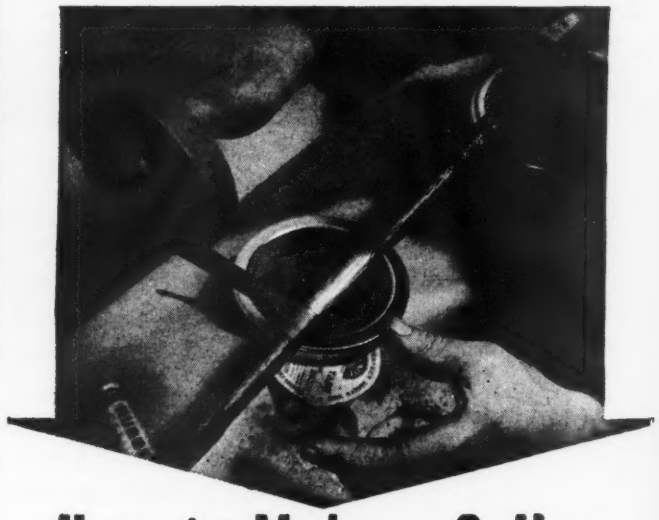

How to Make a Splice in Rubber Insulated Cable

● Illustrated Bulletin OK-1007 describes various splices and tapes for rubber insulated cables up to 5000 volts. To obtain a copy just write The Okonite Company, Passaic, New Jersey.

OKONITE

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Ring Around Bossy!

The ring you see around Bossy is a ring of protection guarding her milk from the moment it is received until it reaches your doorstep . . . sweet, farm-fresh, and cold!

Borden, Sheffield and many another of America's famed milk producers have called on "Headquarters for Mechanical Cooling" not only for dependable equipment—but also for the specialized engineering knowledge and intimate understanding of the dairy industry which is uniquely York's.

For instance, a York contribution which has materially helped the milk business reach its present peak efficiency is High-Temperature Short-Time Pasteurization. This process is the result of intensive study, research, and experimentation extending over a period of many years.

Throughout the nation this York equipment is processing the huge total of 9,772,540 quarts of milk per day!

Not only in the dairy industry but also in the field of fast freezing and in the storage and wider distribution of refrigerated foods, York is supplying the engineering and manufacturing skill necessary to make us a healthier, better-fed nation.

York Corporation, York, Pennsylvania.

YORK *Refrigeration and Air Conditioning*

HEADQUARTERS FOR MECHANICAL COOLING SINCE 1885

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Straight talk about your after-college job

No. 5 A Good Engineer Must Go on Learning

AS BACCALAUREATE SPEAKERS are prone to point out, a degree in engineering is not the ending—but only the end of the beginning.

Here at The Timken Roller Bearing Company, a firm made up largely of engineers, we know it to be a fact that *what* and *how much* an engineer learns during the first years following his graduation usually have a decisive effect on his future.

It seems to us highly important for a young engineer to locate where he will have an *opportunity* to learn.

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■ To give these men the chance to go on learning and developing, our company operates a "Work-as-You-Learn" Plan of training. No classroom work is involved; only productive work in the various departments of our factories and steel mills.

While performing a wide variety of jobs, trainees work with many engineers who are considered the best in their field. They have the chance to observe methods and ask questions about every operation in our business. All the while, they are closely watched. When particular aptitudes show up, trainees are assigned to the line of work for which they are best fitted.

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GE Campus News

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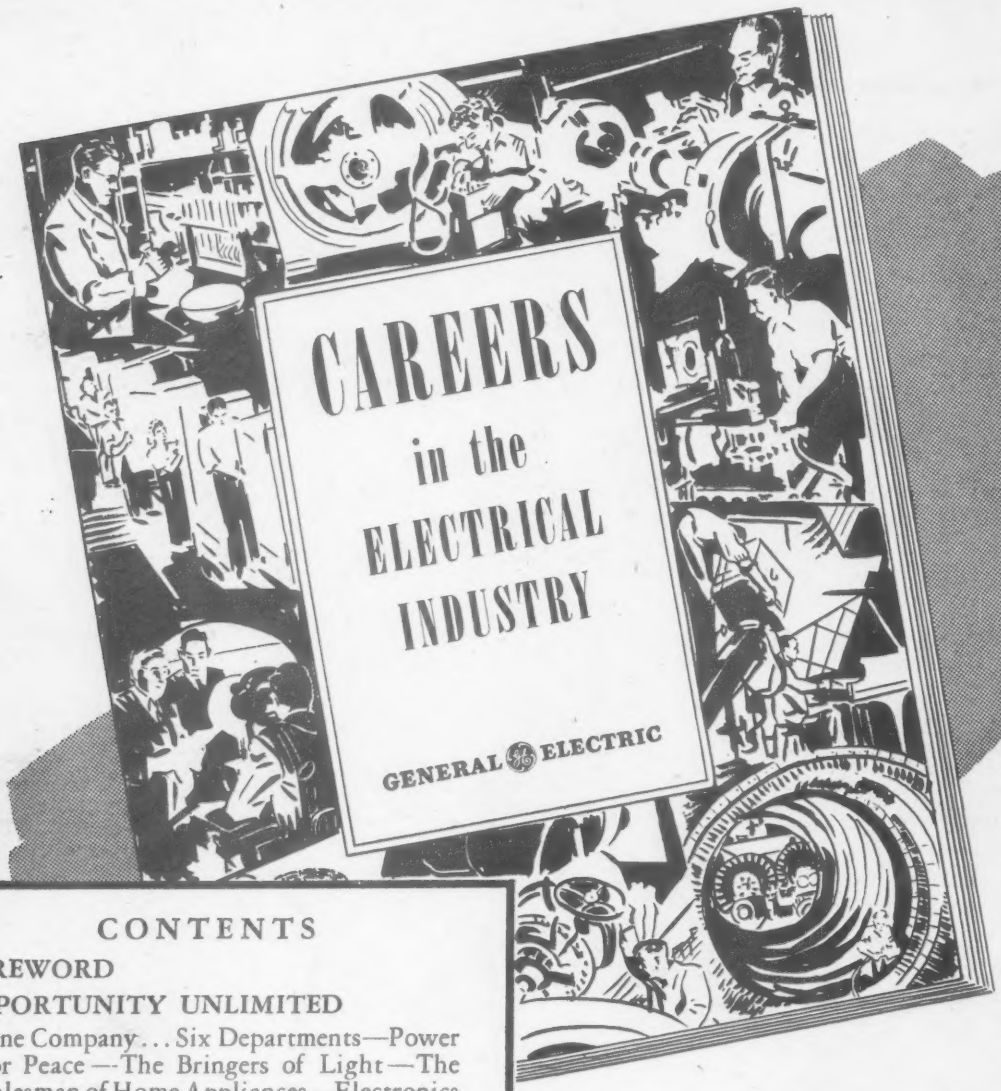

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